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A tough watch to advertise.

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Do your research.

Christopher Ward

christopherward.com

Don't hate the data

Statistics doesn't get the political attention it deserves

PEEAKABOO is a delightful game to play with infants. Lacking as they are in object permanence, the act of hiding your face from a baby before revealing it with a flourish is sure to raise a smile, as their little brains try to figure out what on Earth is going on.

It's somewhat less fun to play this game with the richest and most powerful nation on the planet, but that hasn't stopped the Trump administration from giving it a try.

For decades, US federal agencies have carried out detailed surveys of public health that have informed policy on everything from combatting drug addiction to food insecurity. But these data-gathering exercises are now being cut or cancelled altogether (see page 17).

By metaphorically covering its eyes, the US government seems to hope that these problems will simply go away, but the opposite is true.

As we learned during the height of the covid-19 pandemic, data, surveillance and preparation all go hand in hand

"While not all heroes wear capes, some do their best to fashion one out of a spreadsheet"

when it comes to preventing disaster. Statistical agencies and other data gatherers aren't merely clipboard worriers, but clipboard warriors – our first line of defence against the unknown.

The US isn't the only nation that seems to have forgotten this. For some years now, the UK's Office for National Statistics, once seen as world-class, has been beset by poor-quality data and inaccurate statistics, in part due to underfunding of its activities.

Part of the problem is that this type of work has a boring public image. No politician ever got elected by promising a survey in every letterbox, and statisticians are unlikely to become superstars.

But that has to change. While not all heroes wear capes, some do their best to fashion one out of a spreadsheet, and this type of data drudgery must be applauded and supported. Governing without object permanence is a bad idea, as the US is unfortunately about to find out. ▮

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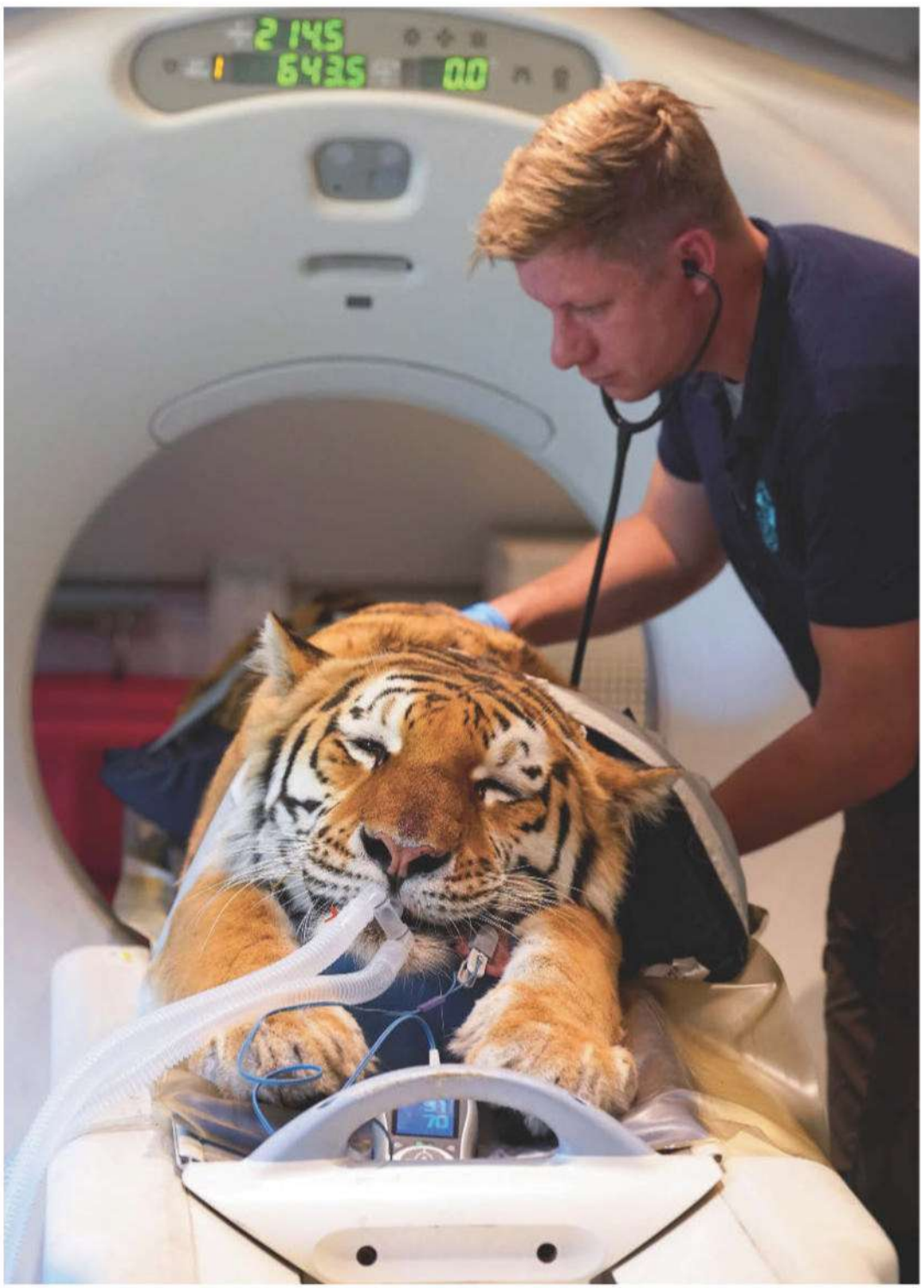

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Zoology

A very big CAT scan

This four-year-old Amur tiger named Luca is being prepared for a CT scan at The Big Cat Sanctuary in Kent, UK. A mobile CT unit was brought to the site for Luca and two other cats – a cheetah and a leopard – with unexplained mobility issues. They were each sedated before the scan and then returned to their habitats.

To read more about Amur tigers, turn to page 25

Ancient humans

Denisovan DNA reveals hidden humans

An entire genome has been sequenced from a Denisovan tooth, which suggests there were more populations of this ancient human species than we thought, explains **Michael Marshall**

FOR only the second time, researchers have obtained the full genome of a Denisovan, a group of ancient humans who lived in Asia. The DNA was extracted from a single 200,000-year-old tooth found in a Siberian cave.

The genome reveals that there were at least three populations of Denisovans, with different histories. It also shows that early Denisovans interbred with an unidentified group of ancient humans – and with a hitherto-unknown population of Neanderthals.

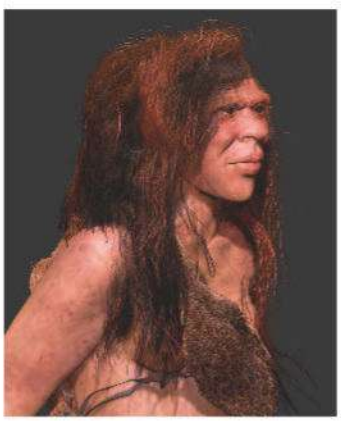
"This is a bombshell paper," says David Reich at Harvard University.

"This study really expanded my understanding of the universe of the Denisovans," says Samantha Brown at the National Research Center on Human Evolution in Spain.

Denisovans were the first ancient humans to be described using just DNA. A sliver of finger bone from Denisova cave in Siberia held DNA unlike that of either modern humans or the Neanderthals from western Eurasia. The genome revealed that Denisovans interbred with modern humans: people in South-East Asia, including the Philippines and Papua New Guinea, carry Denisovan DNA.

Long in the tooth

Since the initial reports in 2010, researchers have identified a handful of other Denisovans, all from East Asia. In June, a skull from Harbin, China, was identified as a Denisovan using molecular evidence, revealing for the first time what a Denisovan face looked like. However, while several specimens have yielded fragments of DNA, the original specimen has been the only one to yield a high-quality genome.



JOHN BAVARO FINE ART/SCIENCE PHOTO LIBRARY

A Neanderthal-Denisovan hybrid (illustration, left) and Denisova cave in Siberia, Russia (below)

Researchers led by Stéphane Peyrégne at the Max Planck Institute for Evolutionary Anthropology in Germany have now added a second. (Peyrégne declined to be interviewed because the study hasn't yet been peer-reviewed.)

The team found a single molar tooth, belonging to a male Denisovan, in Denisova cave in 2020 and sequenced an entire genome from the preserved DNA (bioRxiv, doi.org/qb64).

"Denisovans may have interbred with a Neanderthal group that has yet to be sequenced"

Based on the number of mutations in the genome and comparisons with other ancient humans, the team estimated that the individual lived about 205,000 years ago. In line with this, the sediments in which the tooth was found were dated to 170,000-200,000 years ago. In contrast, the other high-quality genome is from a Denisovan who lived 55,000-75,000 years ago, meaning the new genome reveals a much earlier stage of Denisovan history.

Based on comparisons with other remains from Denisova cave, the team says there seem to have been at least three discrete Denisovan populations. The oldest group included the male whose tooth was analysed. A second group replaced this older population at Denisova cave, thousands of years later.

SHUTTERSTOCK/SALCIDO

"Understanding how early Denisovans were replaced by later Denisovans highlights a significant human event," says Qiaomei Fu at the Institute of Vertebrate Paleontology and Paleoanthropology in China.

The third group, not represented at the cave, interbred with modern humans, based on DNA testing. In other words, all the Denisovan DNA in modern humans comes from a population of Denisovans that we know little or nothing about.

Without a trace

The new genome reveals that Denisovans repeatedly interbred with Neanderthals, who sometimes lived in or near Denisova cave. Crucially, it includes traces of a Neanderthal population that lived 7000-13,000 years before the male Denisovan. These traces don't match any known Neanderthal genome, suggesting the Denisovans interbred with a Neanderthal group that hasn't yet been sequenced.

The Denisovans also seem to have interbred with an unidentified group of ancient humans, one that had evolved independently of Denisovans and modern humans for hundreds of thousands of years. One possibility is *Homo erectus*, which, based on current knowledge, was the first hominin to migrate outside of Africa, living as far afield as Java, Indonesia. However, no DNA has yet been recovered from *H. erectus*, so we can't be sure.

"It's endlessly fascinating that we keep discovering these new populations," says Brown. ▮

To read more about the Denisovans, turn to page 40

Space

We may have finally seen the first generation of stars

Leah Crane

ASTRONOMERS have been looking for behemoth primordial stars, called population III stars, for decades. Now they have found what may be the most promising candidate yet.

Population III stars are expected to be very different from modern, or population I, stars. They would have formed from pristine hydrogen and helium gas, before heavier elements were distributed throughout the universe by supernovae and powerful stellar winds. They are also expected to be bigger and hotter than modern stars.

That is exactly what Eli Visbal at the University of Toledo in Ohio and his colleagues found when they did a detailed analysis of previous James Webb Space Telescope (JWST) observations of a distant galaxy called LAP1-B. It is at a redshift – a number that astronomers use to measure distance – of 6.6, which means we see LAP1-B as it was just about 800 million years after the big bang. That is so far away the only reason we could spot it at all is because its light was magnified by a nearer galaxy cluster in a process called gravitational lensing.

"There should be tons and tons of these all over the observable universe, but we can only look sort of under the lamppost of this cluster that's magnifying the light," says Visbal. When he and his team calculated how many population III star clusters we should find at this redshift, they found that it should be about one – which is what they saw (*The Astrophysical Journal Letters*, doi.org/qb6q). "Our abundance estimate perfectly agreed with [the previous research team] finding one where they did," he says.

Another point in LAP1-B's favour is it only seems to have enough stars to make up a few thousand times the mass of the sun. Other candidates for population III galaxies tend to have much higher stellar masses, inconsistent with simulations of how clusters of population III stars form. "This is the best candidate we have so far," says Visbal.

Most population III stars are expected to have lived and died between about 100 and 400 million years after the big bang, after which there would have been enough heavy elements in the cosmos to form stars that are more similar to the ones we see today. "This object ticks many of the boxes, but I am a bit sceptical because it's late in the game for these stars to be around, and there may be alternatives that might do the job as well," says Ralf Klessen at Heidelberg University in Germany. "It would be super interesting to see a population III star cluster, but statistically this would certainly be an outlier."

However, it is possible pockets of pristine hydrogen and helium could survive longer and form population III stars later on, says Visbal.

"LAP-B1 is an extremely interesting candidate, but it is still far from having the clear, unambiguous signatures that we expect for a clean population III detection," says Roberto Maiolino at the University of Cambridge. ▮

An illustration of population III stars 100 million years after the big bang

NOIRLAB/NSF/AURA/J. DA SILVA/SPACEENGINE/M. ZAMANI

Health

Magnets could revolutionise kidney stone removal

A MAGNETIC device may be able to remove kidney stones more efficiently than standard methods, avoiding the need for repeated surgical procedures.

Kidney stones occur when minerals in urine crystallise. They can be painful when they become lodged inside the kidneys or enter the ureters, tubes that connect the kidneys to the bladder.

They are often treated by breaking them into smaller pieces. This may involve pushing a thin tube with a stone-shattering laser at the end through the bladder into the ureter and kidney, or pulsing ultrasound waves from outside the body.

Surgeons can then remove the stone fragments, usually one by one, using a wire basket that is fed in and out of the urethra. But this repeated retrieval can cause tissue damage. In about 40 per cent of cases, fragments are left behind, partly because especially small ones slip through the basket.

In search of an alternative approach, Joseph Liao at Stanford University in California and his colleagues have developed a magnetic gel, which coats kidney stone fragments, and a magnetic wire, which they used to capture the fragments in a lab dish.

They tested the approach in four pigs, inserting dozens of human kidney stone fragments into the animals' kidneys before injecting the organs with the magnetic gel. Using the magnetic wire inserted through the urethra, they were able to retrieve multiple stone fragments at once (*Device*, doi.org/j7ch).

"It's sort of like using a stick to fish out a snot full of stone fragments, so you can remove a lot in one go"

"It's sort of like using a stick to fish out a snot full of stone fragments, so you can remove a large amount of them in one" go, says Liao.

This suggests the technique would cause less tissue damage, as surgeons would need to go in and out of the kidneys fewer times. It could even completely clear fragments from the kidneys because, unlike wire baskets, the device can catch pieces of any size, says Liao. ▮

Carissa Wong

COP 30

Will COP30 achieve anything?

Expectations are low for the UN climate conference in Belém, Brazil, but the host's pragmatic approach could help make progress on implementation, reports **Luke Taylor**

A DECADE on from the historic COP21 summit in Paris, world leaders are once again about to gather for the latest UN climate conference on 10 November. But with the totemic 1.5°C goal already out of reach and even the less ambitious 2°C target looking like a distant dream, optimism is in short supply.

Based on countries' current pledges, the United Nations Environment Programme estimates the world is on track for 2.3°C to 2.5°C of warming this century. Climatologists say the 30th UN Conference of the Parties in Belém, Brazil, is critical to reset the trajectory of the warming planet, with oceans, forests and polar ice sheets close to tipping points. Concrete action is needed to move the world away from fossil fuels and find the estimated $1.3 trillion needed a year for poorer nations by 2030 to both slow climate change and adapt to its impacts.

"The climate debate is clearly under threat, not just from political decisions but economic, financial and trade decisions too," says Manuel Pulgar-Vidal, global leader of climate and energy at WWF. "That makes it one of the most important COPs since 2009 and equally important as Paris – but in a very different way."

In reality, expectations among negotiators are low. A bold multilateral agreement like the one agreed in Paris is inconceivable in today's fractured political climate.

Last year's COP29 summit in Baku, Azerbaijan, ended in acrimony, with wealthier nations committing to a finance package much smaller than poorer nations were hoping for. Faith in the COP process is so low, there is growing discussion of whether the current model remains fit for purpose.

TON MOLINA/BLOOMBERG VIA GETTY IMAGES

Brazil's environment minister, Marina Silva, speaks at a meeting ahead of COP 30

1.5°C
How much countries had pledged to limit global warming to, above pre-industrial levels

2.5°C
The level of warming now estimated this century

$1.3 tn
Climate funding need for poorer nations by 2030

"Private finance is not showing up, countries want to backtrack on their promises to transition away from fossils and no one is delivering NDCs [national climate pledges]," says Claudio Angelo at Brazilian climate NGO Observatório do Clima. "The mood towards climate action has turned very sour."

Rifts from trade wars and geopolitical conflicts are spilling into climate diplomacy, with the US President Donald Trump leading a backlash against climate action. Trump has withdrawn the US from the Paris Agreement and is vetoing actions to limit fossil fuels while encouraging other countries to follow suit. On 17 October, the International Maritime Organization delayed the formal approval of a plan to cut shipping emissions after Trump threatened sanctions against countries backing the plan.

Slow economic growth, the rising cost of living and anti-incumbent populism are all making it even harder for leaders to implement climate-friendly policies. "2025 is just a bad year for saving the world," says Angelo.

With US support dissolving, Europe was expected to take a larger role in climate diplomacy, but leaders there are divided as defence spending, trade conflicts and energy costs take priority.

Going to the Amazon

Even in the host nation Brazil, President Luiz Inácio Lula da Silva – who campaigned to save the rainforest – has approved the construction of new roads in the Amazon and oil exploration in the Amazon basin with an eye on next year's elections.

Brazil's decision to bring COP to Belém has also been highly controversial. The first-ever Amazon COP is intended to be a reminder of the people and forests impacted by climate change and symbolic of the bold vision necessary to save the world. The environment ministry says more Indigenous people will attend COP30 than any other.

But most participants see the move as reckless. Limited hotel space has caused accommodation prices to soar and left NGOs, diplomats and businesses scrambling for tents, shipping containers and hammocks to sleep in.

With the UN limiting accreditations too, what should be the "implementation COP" could instead become the "empty COP".

"Organisations that had eight accreditations last year got only two this time," says Carla Cardenas at the Rights and Resources Initiative, a coalition of non-profits working to secure land rights for Indigenous people. She says there is concern the attendance of civil society groups who hold leaders to account will be limited, while

COP 30

What's on the agenda at the Belém climate summit

oil and gas lobbies with larger budgets will be unaffected.

On the eve of the summit, there are some signs of positive momentum building. The concerns too few leaders would attend to reach quorum have been alleviated, with figures like UK Prime Minister Keir Starmer making last-minute decisions to travel.

And as multilateralism breaks down, Brazil – with its reputation as a global bridge-builder – just might be the perfect host to hold the creaking climate diplomacy process together.

The presidency is taking a pragmatic approach to negotiations, saying there will probably be no headline-grabbing cover text announced this time. Instead of media-friendly headlines, Brazil wants to focus on implementing existing agreements.

"This is one of the most important COPs since 2009 and equally as important as Paris"

While the world shouldn't expect great international strides forward in Belém, there is still room for cities, regions and companies – who are increasingly taking climate action – to step up, says Thomas Hale at the University of Oxford. "Coalitions of the willing", bands of states who come together to announce environmental initiatives, can still make a significant impact.

"Blockers like the US can sit on the sidelines, but that's not where the groundswell of action is and it's not where the real COP action will be," he says. "We aren't going to see an international decision at COP that will move us forward radically but it can still provide the framework for a lot of positive initiatives to arise." ▮

THIS year's COP is unlikely to result in a major new international agreement; instead, the focus will be on ironing out how existing agreements will work.

Countries were meant to submit updated pledges for cutting emissions, known as nationally determined contributions (NDCs), ahead of the summit. Only 67 of the 195 Paris Agreement signatories had updated their plans by the end of October, with the European Union, which sets climate targets as a bloc, and India among the laggards.

On a more positive note, China has pledged to reduce net greenhouse gas emissions by 7 to 10 per cent from peak levels by 2035. Although insufficient to prevent the world warming by 2°C, it is a sign of progress as the country's first absolute emissions reduction target. "It is a real leap forward from what we have seen in the past – we must see it as positive," says Manuel Pulgar-Vidal, global leader of climate and energy at WWF.

Meanwhile, Brazil is pushing the Belém Action Mechanism for a Just Transition, a new initiative to reframe the world's shift to clean energy as a source of jobs and growth rather than economic pain. It is expected to include pledges, targets and systems to clean up industries and channel funding to communities affected by the changes.

VICTOR MORIYAMA/CLIMATE VISUALS

Forest protection will be one of the key issues discussed

Another initiative, the Global Goal on Adaptation (GGA), is the first attempt to quantify and compare how vulnerable countries are to climate change. It is expected to include around 100 indicators, such as flood risk and food security. The GGA should help the world decide which countries are prioritised for funding, so it is a necessary step to unlocking finance for those facing the worst impacts.

But the world's leaders must not get too caught up in adaptation at the expense of mitigation, says Laurie Laybourn of the climate think thank Strategic Climate Risks Initiative. "There is a scenario where mitigation is pushed onto the back foot but that is a dead end, as less mitigation means more adaptation needs, and we will become stuck in a doom loop."

With wealthy nations failing to deliver the finance required to help developing economies adapt to and prevent climate change, Brazil hopes to get financing back on track with the Baku to Belém Roadmap. The aim is to scale up global climate finance to $1.3 trillion per year by 2035.

Wealthier countries will be trying to find the money through private investment, debt swaps, development bank funding or innovative financing initiatives such as the Tropical Forests Forever Facility (TFFF).

The TFFF is expected to be officially launched at COP30 to finance forest protection through private investment. Brazil and other nations will guarantee the fund with an initial investment so it can then borrow around $100 billion from large private investors at a low interest rate. The TFFF will then reinvest that borrowed money into sustainable projects with higher returns and pay the profits directly to nations that protect their forests.

With few ambitious announcements expected at COP, there is growing pressure on the TFFF to be a success, but it needs nations to invest tens of billions between them. ▮ LT

There may be new targets to help ease the shift to clean energy

EMMANUEL CROSET/AFP VIA GETTY IMAGES

Health

Stem cell therapy lowers risk of heart failure after a heart attack

Grace Wade

PEOPLE who received an infusion of stem cells shortly after a heart attack were less likely to develop heart failure than those treated with standard care, according to the largest such trial to date. The finding provides some of the strongest evidence yet that stem cells can help heal the heart.

After a heart attack, cardiac muscle is permanently damaged and weakened, which often leads to heart failure – when the organ can't pump enough blood to meet the body's demands. Currently, there is no treatment short of a transplant or heart pump that can restore cardiac function.

As a potential solution, researchers have turned to stem cells, which have the unique ability to transform into other cell types. But previous studies investigating their use after a heart attack have shown mixed results. For instance, a 2020 trial involving 375 people found that bone marrow-derived cells, including stem cells that develop into blood cells, failed to lower the risk of death to a greater degree than standard care.

57%

How much the stem cell therapy cut the risk of heart failure by

Armin Attar at Shiraz University in Iran and his colleagues took a different approach: they used mesenchymal stem cells, which can differentiate into structural cells such as cartilage and fat. In addition, these stem cells release molecules that reduce inflammation and encourage surrounding tissues to regenerate.

The team collected mesenchymal stem cells from umbilical cord blood and infused them into the hearts of 136 people within three to seven days of their first heart attack. While these stem cells could be taken from participants' own fat and bone tissue, culturing enough of them for an infusion can take a month, says Attar. Using those from umbilical cord blood allowed the team to administer the treatment much sooner, potentially enhancing the effects, he says. A separate group of 260 people received standard care after their first heart attack.

Three years later, those who underwent stem cell therapy were, on average, 57 per cent less likely to develop heart failure and 78 per cent less likely to be hospitalised for the condition than those receiving standard care (*The BMJ*, doi.org/qb3f). They also saw significant improvements in the heart's ability to pump blood, suggesting the treatment helps heart tissue regenerate after damage. "This is a great step forward," says Attar.

While the therapy didn't reduce the risk of death during the study period, the fact that it lowered hospital admissions is still notable, says Hina Chaudhry at the Icahn School of Medicine at Mount Sinai in New York City.

However, 80 per cent of the participants were male, making it less clear how the therapy affects women, who are more susceptible to heart failure after a heart attack, says Chaudhry. However, Attar and his team didn't find that outcomes differed by sex in a separate analysis. The study was also limited to younger adults: all participants were between 18 and 65 years old. "It would be good to see a breakdown of age groups because younger patients just have more natural regenerative ability, and they recover better from heart damage," says Chaudhry.

Marine biology

Young great whites flipped upside down by hungry orcas

ORCAS in the Gulf of California have been hunting juvenile great white sharks using a clever tactic: flipping them upside down to render them immobile. The discovery suggests there may be a previously unrecognised group of shark-eating orcas in the region.

Only a few orca populations are known to feed on sharks, and until recently, there had only been one known instance, recorded in South Africa, of orcas (*Orcinus orca*) preying on juvenile great whites (*Carcharodon carcharias*).

Erick Higuera, an independent marine biologist in Mexico, and his colleagues captured video footage of orcas in the Gulf of California hunting juvenile great white sharks on two separate occasions. The first, recorded in August 2020, showed five female orcas working together to push a young great white to the surface (*Frontiers in Marine Science*, doi.org/qcft). "The orcas were ramming the great white to flip it upside down," says Higuera.

MARCO VILLEGAS

A pod of orcas photographed while hunting down great white sharks

The manoeuvre forced the shark into a state of temporary paralysis, called tonic immobility. It also allowed the orcas to get at the shark's energy-rich liver.

In August 2022, the team recorded another group of five orcas using the same technique to hunt a young great white around the same location at the same time of year.

Footage from the second incident wasn't clear enough to determine whether these orcas belonged to the same pod. "But it is highly possible," says Higuera.

"Orcas are hunting machines. They are like snipers – they use specific hunting strategies, very specific ones depending on their prey," says Higuera. These findings suggest the orcas belong to a previously unknown, shark-eating group, he says. GW

Space

Satellites face solar storm threat

Charged particles from the sun could affect mega internet constellations like SpaceX's Starlink

Jonathan O'Callaghan

THE number of satellites in orbit is growing at a tremendous rate, but we don't yet have a good understanding of how susceptible they are to solar storms – and that problem is only going to get worse.

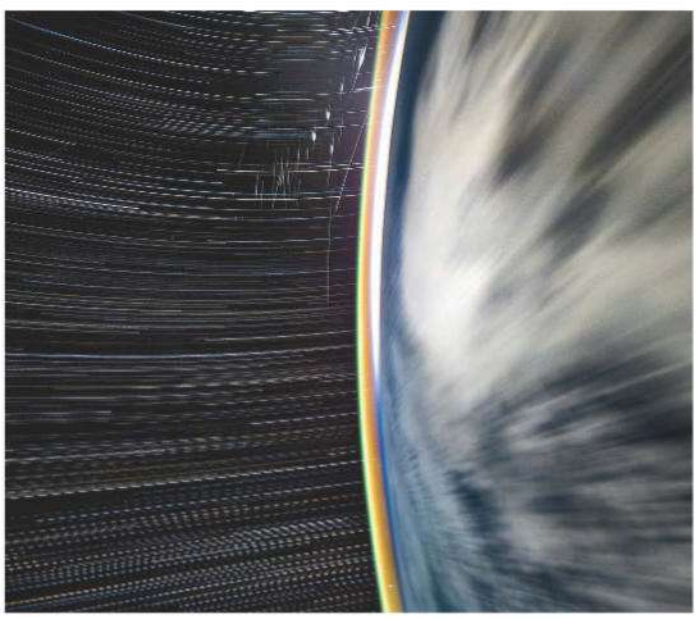
Since May 2019, SpaceX has launched more than 10,000 satellites into its Starlink space internet mega constellation, although about 1000 of these have re-entered Earth's atmosphere at a current rate of one or two a day. The satellites are deployed in a giant mesh around the planet, encompassing pretty much the entire globe.

This means a solar storm and its accompanying geomagnetic storm, when our planet's magnetic field fluctuates in response to charged particles and magnetic fields from the sun, is likely to influence at least some of the satellites, no matter when it occurs.

To investigate the effects of such storms on Starlink, Eunju Kang at the University of California, Irvine, and her colleagues looked at public satellite-tracking data taken during a solar storm in May 2024.

They found that at the peak of the storm, Starlink satellites that were on the side of Earth facing the sun experienced a drop in altitude up to half a kilometre – a small dip in their 550-kilometre orbits, but still significant, as the atmosphere was affected by incoming solar radiation, creating drag on the spacecraft (arXiv, doi.org/qcf4).

Satellites in other regions were greatly affected too, such as those near Earth's poles, where our planet's magnetic field funnels more charged particles from the sun, and those over a region of South America called the South Atlantic Anomaly where, for unknown reasons, the planet's magnetic field is weaker and so the atmosphere is more susceptible to solar activity.



DON PETTIT/NASA

Star trails from a fleet of Starlink satellites, as seen from space

This created an unusual effect in the constellation, according to the data the team had, says Kang. "If one satellite loses its altitude, the neighbouring satellite would also have to compensate," she says, using its on-board ion thrusters to automatically match the affected satellite because the satellites communicate with each other by line-of-sight lasers to maintain the network, creating an undulating effect as other satellites in the chain followed suit. "It's kind of like waves," says team member Sangeetha Abdu Jyothi, also at the University of California, Irvine.

That could pose problems for other satellites trying to navigate around the Starlink constellation to avoid a collision. "When we have less predictability of trajectories, it can increase the risk of collisions," says Abdu Jyothi.

Other public data is also shedding light on the impact of solar storms. Some Starlink customers use an online service called RIPE Atlas to share the status of their connection. Using this data, the team found that network outages were reported during the May 2024 solar storm, as the satellites were disrupted. "There was an immediate spike in packet loss," says Kang, where data doesn't reach its intended destination.

"With a very large solar storm, it will be much worse. But we don't know how much worse"

The research highlights the issues that constellations like Starlink – plus developing constellations like Amazon's Project Kuiper and several efforts in China – will face from solar activity, not just in terms of communications but also in avoiding large changes in position that could cause a collision with other satellites.

In February 2022, a powerful solar storm knocked about 40 just-launched Starlink satellites back into the atmosphere, where they burned up. Earlier this year, other research showed that increased solar activity was speeding up the demise of some Starlink satellites.

In the dark

The solar storm in May 2024 was about three times weaker than the largest solar storm on record, the Carrington event of 1859. A storm of this record size is likely to hit Earth again at some point, with potentially big problems for mega-constellation operators. "With a very large storm, it will be much worse," says Abdu Jyothi. "But we don't know how much worse."

For now, we hopefully have some time to prepare. The May 2024 storm struck during the peak of the sun's activity, which operates on a 22-year cycle. A powerful storm can theoretically strike at any moment, but might start to become more likely in the 2040s, when the star's activity peaks again.

By then, there will probably be tens of thousands, if not hundreds of thousands, more satellites in orbit, compared with the roughly 13,000 in orbit today. "The problem goes up the more satellites you have," says Scott Shambaugh, founder of Leonid Space, a US company that tracks the impact of space weather on satellites.

"When a solar storm hits, we don't yet have great predictive models of how that's going to influence drag on a shorter timescale," says Shambaugh. "That means for the next hours to days, your satellites are not going to be where you think they're going to be." ▮

Ancient humans

Prehistoric crayons provide clues to how Neanderthals created art

Alison George

A REMARKABLE yellow crayon unearthed in Crimea, still sharp after more than 40,000 years, indicates that painting lines on objects was part of Neanderthal culture. This discovery is the firmest evidence yet that some Neanderthal groups used coloured pigments in symbolic ways – behaviour once regarded as the sole domain of our species.

"It's really exciting. It adds a new facet to what we know about symbolic use of colour," says Emma Pomeroy at the University of Cambridge, who wasn't involved with the research.

The use of ochre – an iron-rich mineral with red, yellow or orange hues – has ancient roots, dating back at least 400,000 years in Europe and Africa. Bits of ochre are found at many Neanderthal sites, where they seem to have been used for practical purposes such as tanning clothing and as fire accelerants, as well as sometimes smeared on shell beads.

Neanderthals may have also used ochre to decorate their bodies, clothing and other surfaces, but such traces have long since disappeared. To investigate further, Francesco d'Errico at the University of Bordeaux, France, and his colleagues carried out a detailed analysis of ochre pieces found at Neanderthal sites in Crimea, Ukraine. By studying how ochre pieces were modified by Neanderthals, as well as performing a microscopic analysis of how they became worn down, the researchers could build a picture of how the objects were used.

The tip of an ancient ochre fragment that was used as a crayon

D'ERRICO ET AL., SCI. ADV. 11, EADX4722

The most compelling of these ochre objects was a yellow one that was at least 42,000 years old and had been ground and scraped into a crayon-like shape about 5 to 6 centimetres long (pictured, left). Detailed analysis shows that the tip was worn down through use, then resharpened, indicating that it was reused over time as an implement to make marks (*Science Advances*, doi.org/qb3h).

"It was a tool that had been curated and reshaped several times, which makes it very special," says d'Errico. "It's not just a crayon by shape. It's a crayon because it was used as a crayon. It's something that may have been used on skin or a rock to make a line – the reflection, perhaps, of an artistic activity."

April Nowell at the University of Victoria in Canada concurs. "You only maintain a point on a crayon if you want to make precise lines or designs," she says.

The research team also identified another more ancient broken crayon, perhaps 70,000 years old, made from red ochre.

"It tells us so much just from those small bits of ochre," says Pomeroy. "It's that little bit of humanity that we can relate to. It really brings those individuals into touching distance."

The Crimean crayon discoveries add to the small but growing body of evidence indicating the artistic talents of Neanderthals, such as 57,000-year-old finger carvings on a cave wall in France and mysterious circles crafted from stalagmites 175,000 years ago in another French cave.

They also lend weight to the idea that symbolic behaviour has very deep roots in our evolutionary past, rather than being a capacity that developed relatively recently, only in *Homo sapiens*.

Chemistry

Super-strong fabric could make better bulletproof vests

A MATERIAL is so strong that just a 1.8-millimetre-thick sheet of it could stop a bullet, making it far stronger than Kevlar and possibly the strongest fabric ever made.

Bulletproof vests work by spreading the energy of a projectile through a network of connected fibres. In the case of Kevlar, these fibres are made from aramids, a group of polymer chain chemicals known for having extreme strength. However, under exceptional stress, these polymer chains can slip, limiting the protection they offer.

For the past six years, Jin Zhang at Peking University, China, and his colleagues have been trying to develop even stronger materials.

"Ultra-high dynamic strength and toughness are crucial for fibrous materials in impact-protective applications," says Zhang. "These include bullet-proofing armours, vehicles and aircraft."

Now his team has worked out a method of aligning carbon nanotubes with aramid polymer chains to prevent the molecules from slipping (*Matter*, DOI: 10.1016/j.matt.2025.102496). "Our fabric outperforms Kevlar entirely," says Zhang.

The new material is a "fabricated carbon nanotube/heterocyclic aramid composite", says Zhang, but he hopes to come up with a snappier name "at a later date".

Because the material is stronger than Kevlar, the same bulletproof effect can be achieved with much less material. A single layer of fabric is approximately 0.6 millimetres thick and can reduce the velocity of a bullet travelling at 300 metres per second to 220 m/s, says Zhang. "Based on energy-absorption calculations, roughly three layers of fabric are sufficient to stop the bullet," making a total thickness of 1.8 mm. By comparison, Kevlar must be at least 4 mm thick to stop that same bullet.

"This material is far stronger than Kevlar and possibly the strongest fabric ever made"

"This approach could potentially be used to produce other new composites," says Julie Cairney at the University of Sydney, Australia. She also says the manufacturing strategy is compatible with existing industrial processes.

"These materials could be used for lighter, more effective bulletproof vests and armour, enhancing safety without sacrificing mobility," she says.

James Woodford

Neuroscience

Can't focus due to a lack of sleep? Your brain needs a wash

Carissa Wong

THE reason why you find it so hard to concentrate when you are sleep-deprived may be because your brain is trying to refresh itself.

During sleep, the brain carries out a rinse cycle, where cerebrospinal fluid (CSF) is repeatedly flushed into the organ and out again at the base of the brain. This process clears out metabolic waste that would otherwise damage brain cells.

Laura Lewis at the Massachusetts Institute of Technology and her colleagues wondered whether lapses in attention may result from the brain trying to catch up on rinsing itself when it is awake.

So, they asked 26 people aged between 19 and 40 to get a good night's sleep, then kept them awake all night in a lab two weeks later.

In both cases, the team recorded the participants' brain activity using MRI scans the next morning, while they completed two tasks. During these tests, participants had to push a button whenever they heard a specific tone or saw a cross on a screen turn into a square. As expected, participants failed to press the button more often when they were sleep-deprived.

Analysing the brain scans, the team found that participants lost focus about 2 seconds before CSF was flushed out of the base of their brain. What's more, CSF was drawn back into the brain about 1 second after attention recovered (*Nature Neuroscience*, doi.org/qbx7).

"If you think about the brain-cleaning process like a washing machine, you kind of need to put the water in and then slosh it around and then drain it out, and so we're talking about the sloshing part occurring during these lapses of attention," says Lewis.

Why this leads to attention loss is unclear, but pinpointing the brain circuits responsible could reveal ways to reduce the cognitive effects of sleep deprivation, says Lewis. ▮

Archaeology

Boy's body was mummified and turned green by a copper coffin

Christa Lesté-Lasserre

AN ADOLESCENT boy buried around three centuries ago in a copper box in northern Italy has become the only near-complete green mummy ever known.

Other ancient body parts have been partially mummified or turned green after burial with copper or bronze objects, like the green, mummified hand of a newborn baby clutching a copper coin, buried in a ceramic pot in medieval Hungary.

The Italian mummy, however, is complete except for the feet. Apart from its left leg, it is almost entirely green from skin to bone.

The mummy was discovered in the basement of an ancient villa in Bologna in 1987 and sent for forensic analysis at the University of Bologna. Medical examiners determined it was the body of a boy aged 12 to 14. Since then, it has been carefully stored at the university.

Annamaria Alabiso, a conservation scientist at the University of Rome Tor Vergata, was part of an investigation of the mummy by a wide array of specialists, including geneticists, anthropologists, radiologists, mathematicians, physicists and computer scientists. "It was a very remarkable multidisciplinary collaboration," she says.

The researchers ran multiple in-depth chemical and physical analyses of the mummy. Radiocarbon dating placed the boy's death between 1617 and 1814, says Alabiso, and the mummy shows no clear signs of trauma or disease.

"The effects of heavy metals on preservation are more complex than we might expect"

Copper helped preserve the hard and soft tissues – as expected, given its known antimicrobial properties, says Alabiso. But it also reacted with acids that leaked out of the body and corroded the box. This created copper corrosion products that interacted with chemical compounds in the bone. Little by little, copper ions replaced calcium in the boy's skeleton, solidifying the bone structure in the long term while tinting the affected areas various shades of green (*Journal of Cultural Heritage*, doi.org/qb3z).

These remains were buried between 1617 and 1814

ANNAMARIA ALABISO

As for the skin, it was covered by a crusty film of copper corrosion products called patina, the pale-green coating that develops on copper and bronze statues. The patina developed when copper reacted with water and carbon dioxide as the body broke down, says Alabiso.

"This completely changes our point of view on the role of heavy metals, as their effects on preservation are more complex than we might expect," she says.

The bottom of the box eventually cracked open – possibly due to the acid – letting the liquid spill out so that the body stayed in a cool, dry chamber with little oxygen, which slowed decomposition. The boy's feet might have detached and got lost at this time, says Alabiso.

"It was just a very emotional experience for me to work with these unique human remains," she says.

Giulia Gallo at the Collège de France in Paris recently saw images of the mummy for the first time – and was delighted. "Oh wow, it's incredible!" she says. "It's so beautiful! This whole case study is quite fascinating."

Gallo says the researchers have done an excellent job of exploring all the physical and chemical processes leading to the body's mummification and colour changes. "The evidence strongly substantiates their argument concerning both the preservation and colouration of the tissue and bone." ▮

Palaeontology

Fossil ends big debate over 'tiny *T.rex*'

Palaeontologists may have finally proved that the diminutive *Nanotyrannus* was a separate species

James Woodford

A DINOSAUR fossil thought to be a juvenile *Tyrannosaurus rex* is in fact a fully grown carnivore of a different species, according to researchers who believe they have finally settled a long-running and fierce debate in palaeontology.

The dispute stems from a skull found in Montana's Hell Creek Formation in the 1940s, originally classified as a *Gorgosaurus*, then suggested to be a juvenile *T. rex*. In 1988, other researchers argued that the fossil was in fact an adult of a smaller, related species, which they named *Nanotyrannus lancensis*.

A number of additional fossils have since been identified as *Nanotyrannus*, but many palaeontologists think they are really juvenile *T. rex* specimens.

Now, for the first time, researchers have analysed a complete skeleton that appears to show beyond doubt that *Nanotyrannus* is a separate species.

The skeleton is one of a pair from a fossil specimen nicknamed the "Duelling Dinosaurs", which was discovered by commercial fossil hunters in 2006. The fossil features a *Triceratops* buried alongside what was originally thought to be a juvenile *T. rex* around 67 million years ago.

It wasn't until 2020, when the fossil was purchased by the North Carolina Museum of Natural Sciences, that researchers could properly study the remains.

"When we acquired the specimen, we knew it was exceptional," says Lindsay Zanno at the North Carolina Museum of Natural Sciences. "We had no idea it would turn decades of research on the world's most famous dinosaur on its head."

Zanno, who did the analysis with her colleague James Napoli at Stony Brook University in New York state, says she had originally been an adherent of the juvenile *T. rex* theory, but the evidence has forced her to reconsider.

"*Nanotyrannus* has different nerve and sinus patterns in the skull, more teeth, large hands and a shorter tail," she says. "We know that these traits do not change as animals grow from baby to adult."

MATT ZEHER/NC MUSEUM OF NATURAL SCIENCES; BELOW: ANTHONY HUTCHINGS

This skull, thought to belong to a juvenile *T.rex*, could be a whole other species

"*Nanotyrannus* was one of the scariest dinosaurs. It's the one I would least like to be chased by"

An artist's impression of *Nanotyrannus* in action

Case closed?

According to Zanno and Napoli, detailed analysis of limb bones of the dinosaur confirm it was a fully grown individual about 20 years old, weighing around 700 kilograms and measuring about 5.5 metres in length. "That's about one-tenth the body mass and one-half the length of a fully grown *Tyrannosaurus*," says Zanno.

Zanno and Napoli also reanalysed 200 tyrannosaur fossils and concluded that another near-complete skeleton from the Hell Creek Formation, known as Jane, which was thought to be a *T. rex* teenager, has also been incorrectly classified. They say Jane is actually a new species in the genus *Nanotyrannus*, which they call *Nanotyrannus lethaeus* (*Nature*, doi.org/qb6m).

"We only have one skeleton of *N. lethaeus*, but its anatomy suggests it was a larger species," says Zanno. "The sinus patterns in the palate and the shape of the bone behind the eye are unique."

"For my money, *Nanotyrannus* was one of the scariest dinosaur predators," says Scott Persons at South Carolina State Museum. "It's the one I would least like to be chased by. It was extremely long-legged and armed with a wicked thumb claw.

"We can think of *Nanotyrannus* and *Tyrannosaurus* as analogues to modern cheetahs and lions. Yes, they have a generally similar body plan, but they were specialised for different ways of hunting."

Thomas Carr at Carthage College in Wisconsin, who has long sat in the juvenile *T.rex* camp, says the new evidence is "pretty conclusive" that the Duelling Dinosaur specimen is a "near-adult of a species that is not *T. rex*".

And Holly Ballard at Oklahoma State University, who led a 2020 study refuting the *Nanotyrannus* claims, says she is "fine" with the team's conclusion that the fossil is of an individual approaching adult size.

But neither Ballard nor Carr is convinced that the other fossil, Jane, represents a new *Nanotyrannus* species. "Jane is still growing and is already bigger than *N. lancensis*, so to argue it's a new taxon instead of a juvenile *T. rex*... We're back to the same old debates," says Ballard.

"In addition to that, if every small tyrannosaur from the Hell Creek Formation is *Nanotyrannus*, then where are the juvenile *T. rex*?" says Carr. "That part of the picture doesn't add up. In terms of fossils, we simply haven't collected enough Hell Creek Formation tyrannosaurs to truly understand what was going on with the early growth stages of *T. rex*." ▮

Health

The gut microbiome may play a role in shaping our personality

Chris Simms

RATS given gut microbiome transplants from exuberant human toddlers seem keener to explore their environment. This finding hints that the microorganisms inhabiting our guts when we are children play a role in shaping our personalities.

"It suggests our microbes are active participants in emotional development, not just passive passengers," says Harriët Schellekens at University College Cork in Ireland, who wasn't involved in the study.

A growing body of research has linked the communities of microbes that reside in our guts to our health, emotions and moods.

It isn't entirely clear if the microbes cause these changes or if the microbial community alters as a result of behaviour, but there are some signs that altering the make-up of the microbiome can influence mood. For example, faecal transplants from people with depression to rats seem to induce depressive behaviour in the rodents, and people with depression treated with faecal transplants have seen their symptoms improve in preliminary trials.

To shed more light on how the gut microbiome may be linked to temperament, Anna Aatsinki at the University of Turku in Finland and her colleagues transplanted faeces from toddlers to young rats.

First, they evaluated the personalities of 27 2.5-year-old toddlers using a standard temperament assessment and an exercise in which children were invited to play with a bubble gun.

A child's behaviour could be influenced by the bacteria in their gut

KATE_SEPT2004/GETTY IMAGES

Based on these assessments, the researchers judged 10 of the toddlers as exuberant, and eight as inhibited and introverted. From these groups, they selected four exuberant and four inhibited toddlers – half boys, half girls – and collected samples of their faeces.

Faecal samples with added glycerol or control samples of glycerol were transferred to 53 rats aged 22 or 23 days old, which had already had their bowels cleansed.

Aatsinki and her colleagues then put the rats through a series of behavioural tests in different situations. They found that rats with microbiomes from toddlers with high exuberance traits showed more exploratory behaviour than rats with a control transplant or those receiving faeces from inhibited toddlers (bioRxiv, doi.org/qb34).

To explore how gut microbes might influence the brain, they also analysed brain tissue, looking for changes in gene activity. This showed that rats given transplants from inhibited toddlers had less activity in neurons that produce dopamine, a brain chemical linked to reward for risk-taking behaviour.

"This study beautifully shows how the gut microbiome in early life may help shape behavioural tendencies," says Schellekens.

The influence shouldn't be overstated though, says Aatsinki. "Overall, adults' temperament traits are relatively strongly correlated with genetics, but environmental factors, potentially including the microbiome, could influence the variance of some behaviours." ▮

Space

Small galaxy is home to a shockingly enormous black hole

A NEARBY galaxy once thought to be dominated by dark matter seems to have a surprise supermassive black hole at its centre. Segue 1 is barely a galaxy, with only about 1000 stars compared with the Milky Way's hundreds of billions, yet it appears to be home to a black hole about 10 times as massive as all its stars combined.

Segue 1 and other similar dwarf galaxies don't have enough stars to provide the gravity needed to hold them together. Physicists have long assumed they are chock-full of the mysterious substance dark matter, which we can't see but could generate the extra gravity required.

So when Nathaniel Lujan at the University of Texas at San Antonio and his colleagues began testing computer models of Segue 1, they expected the best-fitting model would be one dominated by dark matter. "I was running hundreds of thousands of models, and I wasn't finding anything that fit," says Lujan. "And then finally I decided to mess with the black hole mass and all of a sudden it started to work."

The model that fit best with our observations of Segue 1 included a black hole with a mass about 450,000 times the mass of the sun (*The Astrophysical Journal Letters*, doi.org/g977m7). This was surprising not only because of the galaxy's lack of stars, but also its age – the few stars that it does have indicate it formed only about 400 million years after the very beginning of star formation in the universe. That doesn't leave much time to produce such a colossal black hole, especially with the much larger Milky Way siphoning off most of the gas that could feed it from Segue 1 shortly after its birth.

"This probably means that there are more supermassive black holes than we thought"

"This probably means that there are more supermassive black holes than we thought," says Lujan. If so, they could account for some of the gravity that has been attributed to dark matter – but we don't know if Segue 1 is representative of all dwarf galaxies, so the hunt for more supermassive black holes is on. ▮

Leah Crane

Technology

We may have found a way to train AI 1000 times faster and cut energy use

Matthew Sparkes

ANALOGUE computers that rapidly solve a key type of equation used in training artificial intelligence models could offer a potential solution to the growing energy consumption in data centres caused by the AI boom.

Devices like laptops and smartphones are known as digital computers because they store and process data as a series of binary digits, either 0 or 1, and can be programmed to solve a range of problems. In contrast, analogue computers are normally designed to solve just one specific problem. They store and process data using quantities that can vary continuously, such as electrical resistance, rather than discrete 0s and 1s.

Analogue computers can excel at speed and energy efficiency, but have previously lacked the accuracy of their digital counterparts. Now, Zhong Sun at Peking University, China, and his colleagues have created a pair of analogue chips that work together to accurately solve matrix equations – a fundamental part of sending data over telecom networks, running large scientific simulations or training AI models (*Nature Electronics*, doi.org/qbzb).

The first chip outputs a low-precision solution to matrix calculations very rapidly,

"Analogue computers could help reduce the energy demands of our ever-growing reliance on AI"

while a second runs an iterative refinement algorithm to analyse the error rates of the first chip and so improve accuracy. Sun says that the first chip produces results with an error rate of around 1 per cent, but that after three cycles of the second chip, this drops to 0.0000001 per cent – which he says matches the precision of standard digital calculations.

So far, the researchers have built chips capable of solving 16 by 16 matrices, or those with 256 variables, which could have applications for some small problems. But Sun admits that tackling the questions used in today's large AI models would require far larger circuits, perhaps a million by a million.

But one advantage analogue chips have over digital is that larger matrices don't take any longer to solve, while digital chips struggle exponentially as the matrix size increases. That means the throughput – the amount of data crunched per second – of a 32 by 32 matrix chip would beat that of a Nvidia H100 GPU, one of the high-end chips used to train AI today.

Theoretically, scaling further could see throughput reach 1000 times that of digital chips like GPUs, while using 100 times less energy, says Sun. But he is quick to point out that real-world tasks may stray outside the extremely narrow capabilities of their circuits, leading to smaller gains.

"It's only a comparison of speed, and for real applications, the problem may be different," says Sun. "Our chip can only do matrix computations. If matrix computation occupies most of the computing task, it represents a very significant acceleration for the problem, but if not, it will be a limited speed-up."

Sun says that because of this, the most likely outcome is the creation of hybrid chips, where a GPU features some analogue circuits that handle very specific parts of problems – but even that is probably some years away.

James Millen at King's College London says that matrix calculations are a key process in training AI models and that analogue computing offers a potential boost.

"Doing this more efficiently could help reduce the huge energy demands of our ever-growing reliance on AI," says Millen. ▮

Environment

Carbon calculators might not capture the full cost of flying

THE true impact of flying could be several times higher than standard carbon dioxide calculators suggest.

"The numbers are shocking," says Jhuma Sadhukhan at the University of Surrey in the UK. She and her colleagues compared the figures from four established calculators with one they created.

At the time of the study, the International Civil Aviation Organization (ICAO) flight calculator suggested a first-class flight from Singapore to Zurich on a B777 plane would produce the equivalent of around 3000 kilograms of CO_2, while the Google Travel Impact Model (TIM) put it at around 5000 kg. But according to this new calculator, the actual number is more than 14,000 kg (*Communications Earth & Environment*, doi.org/g98f6r).

The calculator, called the Air Travel Passenger Dynamic Emissions Calculator (ATP-DEC), differs from others in two ways. Firstly, rather than assume a flight takes the ideal route, it uses past flight data to estimate the most likely route, flight time and time spent taxiing before take-off and after landing, as well as how full an aeroplane is likely to be.

The second difference is that it accounts for all the known ways in which flying can affect the climate, including the formation of contrails,

MARCOS DEL MAZO/LIGHTROCKET VIA GETTY IMAGES

Air travel is known to be a big source of carbon dioxide emissions

nitrogen dioxides and water vapour.

A spokesperson for ICAO said the methodology behind the ICAO Carbon Emissions Calculator can be found on its website. "The calculator does not quantify the climate change impact of aircraft emissions using the Radiative Forcing Index [a measure that accounts for non-CO_2 gases] or other such multipliers, as scientific consensus has not yet been reached," they said in a statement.

Dan Rutherford at the International Council on Clean Transportation, a non-profit that helps advise Google on how to refine its CO_2 calculator, says "We continue to improve the model, including the incorporation of short-lived climate pollutants like contrails, in order to maximise its usefulness to the flying public." ▮

Michael Le Page

US public health system is flying blind after major cuts

The loss of government workers responsible for crucial public health surveys could leave the US without the information it needs to respond to future threats, finds **Grace Wade**

CRITICAL public health surveys in the US are facing deep cuts after a series of layoffs hit government employees working on key nationwide data systems. These datasets measure everything from births and deaths to nutrition and substance use. Without them, it will be nearly impossible to identify, monitor or respond to health threats across the country.

"It is like trying to fly a plane and you have no speed gauge, you have no altimeter, you don't know your elevation, you don't know how far it is to the nearest airport. You have none of the information that you need," says Susan Mayne, a former director of the Center for Food Safety and Applied Nutrition at the US Food and Drug Administration.

During his second term, President Donald Trump has made a concerted effort to shrink the US government. The US Department of Health and Human Services (HHS) has been one of his administration's main targets. In March, the agency's workforce fell from 82,000 employees to 62,000. Roughly 1100 additional layoffs were announced in October, though a court order temporarily paused these amid the ongoing government shutdown.

Most of the cuts have targeted staff in human resources, information technology and communications, but some have hit those running crucial public health surveys. HHS didn't respond to *New Scientist*'s questions about the total number of layoffs, so it is unclear how many public health surveys have been affected, but so far at least five have.

The National Survey on Drug Use and Health (NSDUH) was one of the first to go. In April, HHS terminated all 17 people running it, impairing the country's only nationwide survey of drug use, addiction and mental health.

CHIP SOMODEVILLA/GETTY IMAGES

The Trump administration is shrinking the size of the US government

Then, in September, the government ended the Household Food Security reports, which monitor food insecurity throughout the country, claiming in a statement that "these redundant, costly, politicised and extraneous studies do nothing more than fear monger".

"It's like trying to fly a plane and you have no speed gauge, no altimeter, you don't know your elevation"

However, the survey has received bipartisan support for decades, said Georgia Machell at the National WIC Association, a non-profit supporting the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). This government programme provides low-income families with food assistance and nutrition education. "Programs like WIC rely on these national-level data to understand the broader picture of hunger and food insecurity in our nation, allowing resources to be directed where they are most needed," said Machell in a statement.

Most recently, HHS gutted the National Center for Health Statistics (NCHS), terminating about 100 positions, according to the Data Foundation, a Washington DC-based non-profit organisation advocating for open data and evidence-informed policy. This includes most of the staff behind the National Vital Statistics System, which tracks births and deaths across the US and monitors the country's leading causes of deaths and maternal mortality rates.

Knock-on effects

The entire team running the National Death Index was also affected, says former NCHS director Charles Rothwell. This little-known database contains identifying information about every death in the US, including the person's name, place of residence, cause of death and, in many cases, their social security number, which allows for robust tracking. "This is the only dataset like this available," says Rothwell.

Because it stores highly sensitive data, it doesn't publish any reports. Instead, it assists other agencies and researchers conducting long-term studies. As such, a blow to the National Death Index will have knock-on effects across a range of public health surveys, he says.

HHS told *New Scientist* it "is not currently taking actions to implement or administer" the NCHS layoffs, citing the recent court order. However, it didn't respond to questions about whether it would do so once the government shutdown ends, and if so, how it will maintain these databases.

Employees responsible for planning the National Health and Nutrition Examination Survey (NHANES) were also laid off in October. This survey is one of – if not the – most comprehensive assessments of health, diet and illness in the US. It deploys a fleet of mobile clinics to conduct blood and urine testing, bone-density scans and oral health examinations to monitor diet, environmental exposures and the prevalence of illness nationwide. "It really sets the foundation for nutrition and public-health policies," says Mayne.

HHS appears to have reversed terminations of NHANES staff, according to the Data Foundation. But the fact these positions were cut in the first place is deeply concerning – and the same goes for those working on other major public health surveys. These datasets steer public health policy in the US. Weaken or remove them, and the entire system could come crashing down. ▮

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Health

Men may need more exercise than women

Christa Lesté-Lasserre

MEN over 50 may have to exercise more than twice as much as women to get the same heart health benefits. An analysis has found that men in this age group need nearly 9 hours per week of moderate to vigorous activity to gain a 30 per cent drop in coronary heart disease risk, compared with about 4 hours for women.

Scientists already suspected that women got more cardiac benefits than men based on self-reported exercise data, but such figures aren't always accurate.

To overcome that problem, Jiajin Chen at Xiamen University in China and his colleagues retrieved data from wrist-worn activity trackers collected by the UK Biobank study and compared that with participants' health records over a period of about eight years.

First, the team analysed information from 80,243 adults, with an average age of 61, who had no personal history of coronary heart disease. Among women, those who did at least 150 minutes of moderate to vigorous exercise per week saw a 22 per cent drop in their risk of developing coronary heart disease. For men, getting this amount of exercise was linked to just a 17 per cent drop.

Achieving a 30 per cent drop required much more exercise, with a notable sex difference: 250 minutes for women, and 530 for men (*Nature Cardiovascular Research*, doi.org/g979wq).

Then, the team looked at 5169 participants who had already been diagnosed with coronary heart disease. They had an average age of 67 and two-thirds of them were men. With 150 minutes of weekly moderate to vigorous exercise, women were 70 per cent less likely to die over the next roughly eight years – for any reason – than women who exercised less. By contrast, men who did 150 minutes of moderate to vigorous exercise each week were only about 20 per cent less likely to die than their less active counterparts.

"This isn't bad news for men, it's just something we should know about," says Nir Eynon at Monash University, Australia. "Once we know, we can do better – we can do more exercise. And while it's reassuring for women who are busy all the time, I also think women should not miss the fact that they need to exercise as well."

The benefits of exercise for your heart health aren't equal for men and women over 50

ALEXANDRA BUXBAUM/SIPA USA/ALAMY

Views

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Emily H. Wilson is entranced by sci-fi novel *Slow Gods* p26

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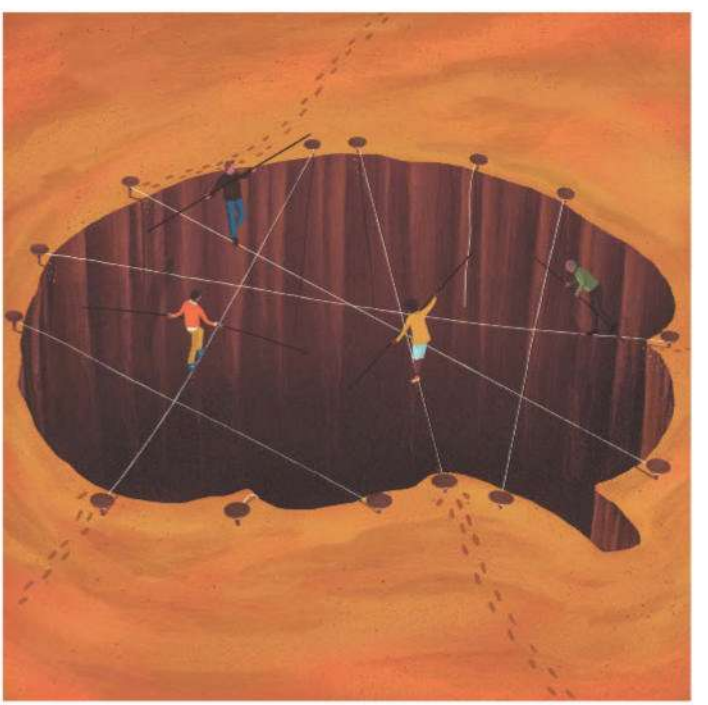
Let's hear it for the horror fans p27

Comment

Nothing's certain

Human minds abhor uncertainty. This is a problem for liberal democracy, but there are solutions, say **Florence Gaub** and **Liya Yu**



SIMONE ROTELLA

WHEN it comes to understanding the ups and downs of liberal democracy, conventional research looks at drivers such as economics, emotions and education. But another area is just as crucial: neurology.

After all, liberal democracy challenges our brain in ways that other political systems don't. Where dictatorships offer certainty about the future – just think of Adolf Hitler's 1000-year time horizon – liberal democracy offers almost none, save certain election dates. It presents the future as an open space to be shaped by us and our choices, nothing more, nothing less.

Politically, that is an achievement. Cognitively, it can be terrifying. Until the arrival of liberal democracy, the future was in the hands of a select few. Preservation, not progress, was the status quo. Neurologically, the ambiguity and flexibility of the future that comes with liberal democracy can be a challenge because it brings with it uncertainty – something human minds abhor. Studies show that uncertainty is a neurological tension state more uncomfortable than the certainty of receiving an electric shock, and history is littered with attempts to reduce uncertainty to more tolerable levels, from insurance to the weather forecast.

Where you fall on the tolerance-to-uncertainty spectrum depends on a number of things – such as culture, age and gender – but it is also to do with how your brain is wired. Political neuroscience shows that the brains of people with conservative views favour security and avoid open-ended solutions with no clear closure. They tend to have increased volume in their amygdala, the region responsible for threat signalling. This means they feel more discomfort in the face of novelty and surprise.

Liberal brains, in turn, have a higher tolerance for uncertainty and conflict, as they have more grey matter volume in a brain area implicated in the processing of ambiguity called the anterior cingulate cortex. Liberal democracy can accommodate both under less stressful circumstances, because although conservatives and liberals might have different neural signatures regarding their preferences for the future, evolutionarily, every human can still engage in mental time travel and imagine different futures.

But when uncertainty levels rise – say, because several future trajectories are unclear, from the environment to technology and social norms – certain brains might be pushed too far out of their comfort zone. To remedy this tension state, such people will be susceptible to illusions of certainty provided by populist, authoritarian political actors who promise decisionism and black-and-white world views. Certainty, or mirages thereof, can be generated by rejecting anything new – medicines, technologies – or foreign people, cultures and religions. This reduces uncertainty by closing the future off, erasing ambiguity and anxiety. That can appease an anxious brain.

This doesn't mean we are stuck with illiberal brains. Rather, liberal democracies need to communicate more honestly with their electorate that embracing liberalism might not come naturally. The strategies we need to adopt in education, public discourse and civil society should be based on insights into how to overcome illiberal mechanisms at the neurological level.

We need to signal to our brains what can be won through cooperation across identity and interest groups, and how, ultimately, the big global challenges of our time can be overcome only by overcoming our brains' vulnerabilities together. ▮

Florence Gaub is author of *The Future: A manual* (Hurst, 2026). Liya Yu is author of *Vulnerable Minds: The neuropolitics of divided societies* (Columbia UP).

Lost in space-time

Cosmic speed limit

There is no such thing as objective simultaneity – things happening at the same time – and all because light has a speed. Pretty wild, right? says **Leah Crane**

Leah Crane is a physics and space reporter at *New Scientist*, and author of this month's Lost in space-time newsletter.

IF YOU have taken a university-level physics class, you will have "fond" memories of being asked to measure the speed of light and – if, over several hours, you managed to line up your mirrors, lenses and light source just right – getting an answer of just under 300 million metres per second. It is a foundational constant in physics, one that is crucial to understand if you want to learn anything at all about the universe.

When we look out into the cosmos, light is our only resource – well, not quite our only one, but gravitational waves are fairly limited in what they can show us right now, so please forgive the slight exaggeration. Practically every breakthrough in astronomy and cosmology is based on collecting light that has travelled for millions or billions of years from the edges of reality. The time light takes to travel may be among the most useful – and least intuitive – parts of physics.

People have been arguing about the speed of light since long before we had any idea what light actually was. For centuries, many thought that light was actually emitted from your eye, like a sort of lantern, in part because of how some animals' eyes glow at certain angles in the dark. Despite that, they still argued about whether light was transmitted instantaneously or took time to travel, and this wasn't properly tested until the 17th century.

The earliest attempts at quantifying it involved setting up a lantern some distance from an observer and measuring the difference in time between the lantern being opened and the observer seeing its light. That didn't work – Galileo and his contemporaries couldn't get a conclusive measurement because the observers were too close to the lanterns – and eventually scientists moved on to more complex and precise methods. By the mid-18th century, measured values were within a few per cent of the currently accepted number of 299,792,458 metres per second for the speed of light in a vacuum.

But why is there a speed limit at all? The answer lies in perhaps the most famous equation ever written: $e = mc^2$. At its basest level, this means we can think of energy and mass as interchangeable. When objects are moving at extraordinarily high (or relativistic) speeds,

> **"The time light takes to travel may be among the most useful – and least intuitive – parts of physics"**

I like to think of them as just having a momentum, which is a combination of their mass and velocity. If you want to speed up an object, you have to keep pouring more and more energy into it. A massive object moving at the speed of light would have infinite momentum, which you can think of as infinite energy or infinite mass. That simply isn't possible: by the time the object got close to the speed of light, its mass would become so enormous that it would be impossible to accelerate it further. But light doesn't have mass, so it sidesteps this problem.

Instead of being frustrated by this cosmic speed limit, we can rejoice, because the speed of light has one very important consequence: the entire idea of consequences. All of physics, our entire understanding of everything, is based on a foundation of causality, the idea that effect always follows cause and never the other way around.

Think about it this way: as I approach the speed of light, you observe time slowing down for me. If I reached the speed of light, it would stop. And if I kept going even faster, it would start going in the opposite direction. By travelling faster than the speed of light, as observed from your reference frame, I would be moving backwards in time. If I (somehow) sent you a signal that travelled faster than the speed of light, you would get it before I sent it. Without our universal speed limit, it would be impossible to tell which event caused what effect – everything about the universe would be pretty much incomprehensible.

That leads me to my final point, one that I find both mind-blowing and fun to contemplate. If every signal takes time to travel, and time moves differently in reference frames that are travelling at different speeds with respect to one another, what does it mean for two events to take place "at the same time"?

If I wink at myself in the mirror, the wink I see reflected back actually happens just a tiny slice of time later than the wink that I physically did, because the light had to bounce off my face, then the mirror, then come back to my eyes to perceive. If you say that two events at different locations in space occurred at the same time, I have to ask: "According to whom?" Depending on the distance between the two locations, it is possible that for one observer, event 1 will have happened first, and for another, event 2 will have preceded event 1. There's no such thing as objective simultaneity – no such thing as "the same time" – and all because light has a speed. Wild, right? ▮

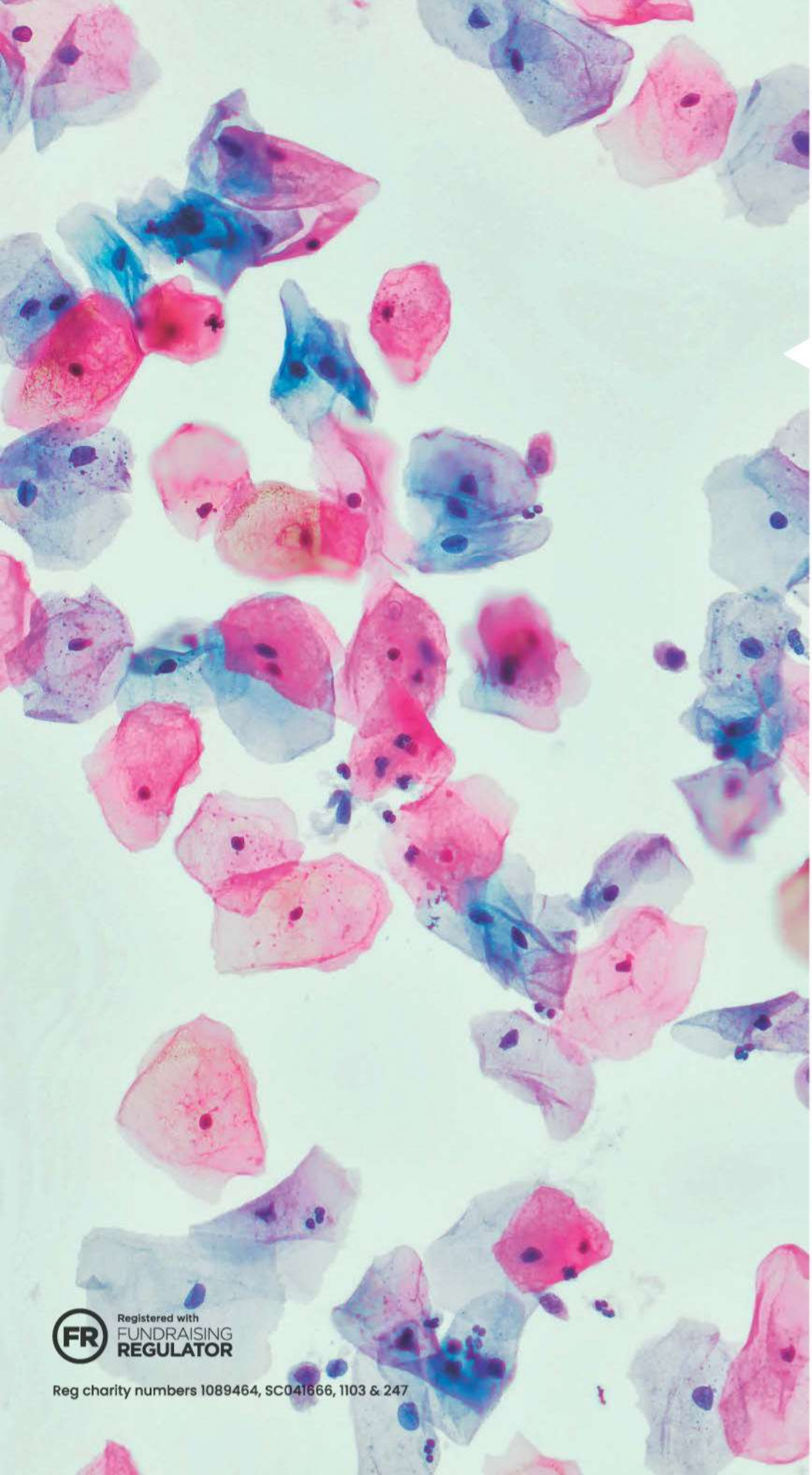
Leah's week

What I'm reading
Katabasis *by R.F. Kuang, a magical journey through academia and hell, which I just started after loving all of Kuang's other writing.*

What I'm watching
Dhoom 2*, perhaps the best heist movie ever made.*

What I'm working on
Perfecting my focaccia recipe.

This column appears monthly. Up next week: Annalee Newitz



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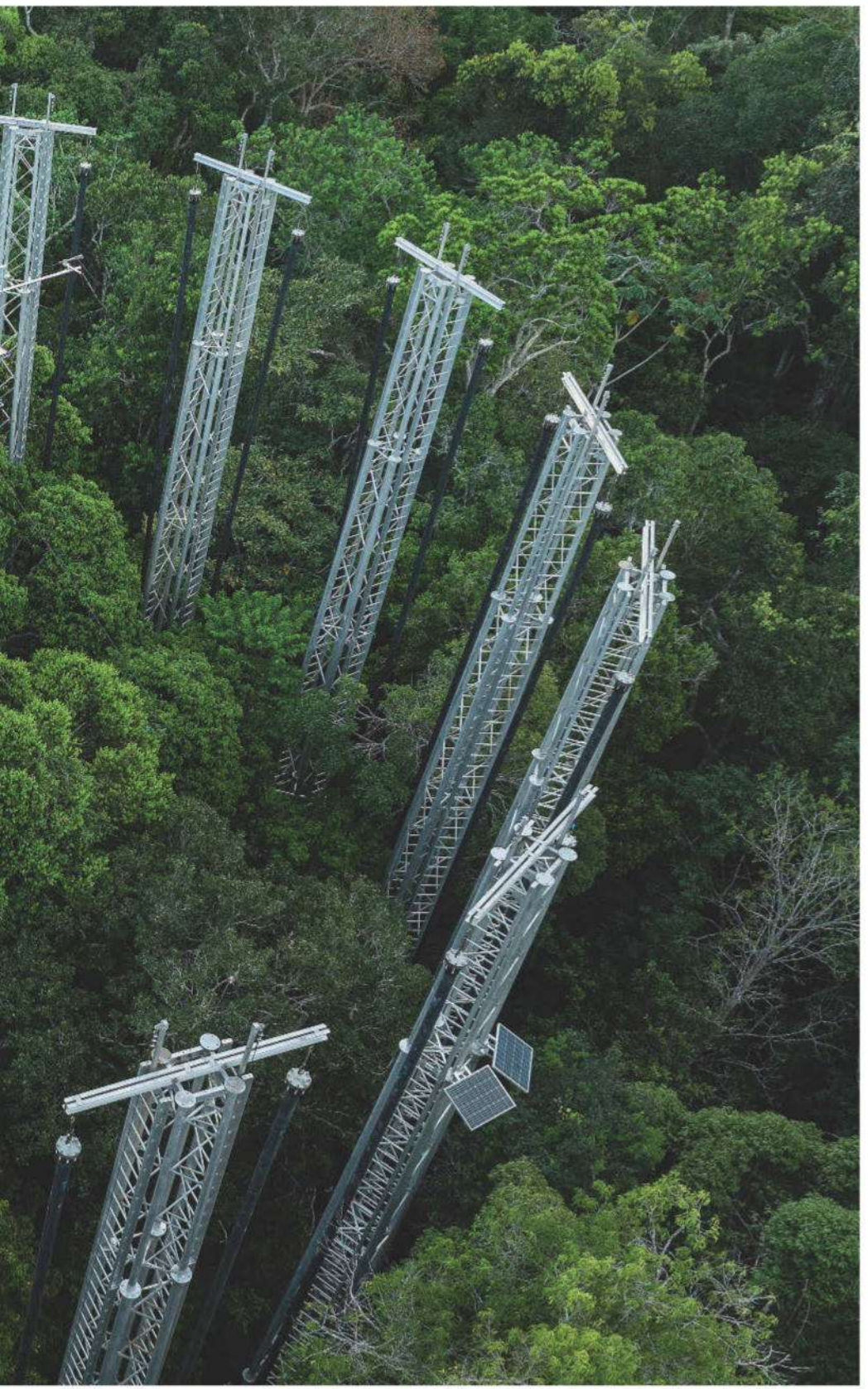

Tree rings

Photographer **Lalo de Almeida**
Agency **Panos Pictures**

DEEP in the Amazon rainforest, an unusual experiment is deliberately pumping out carbon dioxide to measure how flora and fauna react to the levels we expect to reach in the future.

Photographer Lalo de Almeida captured these images of the Amazon Free-Air CO_2 Enrichment (AmazonFACE) experiment, a project 80 kilometres north of the Brazilian city of Manaus that is run by the country's National Institute of Amazonian Research. He likened it to "a hidden spying facility out of a Bond movie".

The project covers a wide area with six circles of 35-metre-tall metal towers (main image). Each circle is 30 metres in diameter and composed of 16 towers laden with sensors. Half of these rings emit CO_2 and the others act as controls.

Each tower that emits CO_2 increases the local concentration of the gas by 50 per cent to simulate the expected increase in emissions in the coming decades. The below image shows scientists collecting data on plants in one of the rings.

The experiment's results could help us better understand what level of emissions is possible before further disastrous consequences kick in.

Matthew Sparkes

All mixed up

The new science of microchimerism brings with it profound implications for medicine, and even what it means to be human, says **Helen Thomson**

Book
Hidden Guests
Lise Barnéoud, translated by Bronwyn Haslam
Greystone Books

MY CHILDREN were conceived using donated eggs, so you would be forgiven for assuming we share no genetic material. Yet science has proved this isn't entirely true.

We now know that during pregnancy, fetal cells cross the placenta into the mother, embedding themselves in every organ yet studied. Likewise, maternal cells, and even those that crossed from my mum to me, can make their way into my kids. And things might get even more chimeric – I have older sisters, so their cells, having passed into my mum during their own gestation, might have then found their way into me and, in turn, into my kids.

This fascinating idea – that we are a holobiont, composed not only of human cells and microbes but also fragments of others – and its implications sit at the heart of *Hidden Guests: Migrating cells and how the new science of microchimerism is redefining human identity* by Lise Barnéoud.

Barnéoud traces not only the serendipitous discovery of these microchimeric cells, but also how their interpretation has been shaped by culture and politics. The notion that fragments of parents, siblings and even fetuses embed themselves within our bodies and brains can stimulate wide-ranging feelings.

"Some people find it comforting to be connected to loved ones they have lost... while others decry yet another way for men to extend their control," she says, referring to the fact that some anti-abortion activists have claimed that fetal cells "haunt" women who have had abortions, triggering diseases to punish them.

"Some find it comforting to be connected to loved ones they have lost..."

Thankfully, Barnéoud mostly sticks to the scientific evidence. She follows researchers through their mistakes, doubts and eureka moments, showing how cells of fetal origin can both help and harm. They appear to assist in tissue repair and fight against tumours, but are also implicated in autoimmune conditions. Barnéoud approaches more emotive areas with sensitivity, while explaining, for example, how cells from miscarried fetuses can embed themselves in mothers' bodies for decades.

She also reveals how their presence scrambles classic genetic inheritance rules, producing extraordinary biological mysteries. There's the woman who only shares genetics with one out of three of her sons, for example, despite conceiving them all with her own eggs. Or the woman with hepatitis C whose liver is riddled with cells whose DNA matches that of two previous partners, probably originating from pregnancies that were terminated decades earlier.

"The presence of microchimeric cells can produce extraordinary biological mysteries"

LOIS FORD HAMMILL ENNIUM IMAGES

Or the Olympic cyclist who tried to blame a "vanishing twin" (a fraternal twin whose DNA merges with another in utero) for his suspiciously mixed blood types.

Hidden Guests is written with clarity, full of helpful metaphors and analogies. Barnéoud, a journalist, compares our body's microchimeric cells to stars from other galaxies "bearing molecular signatures other than our own". And when they turn up in tumours, she likens the untested assumption that the cells are causing the growths to blaming firefighters for starting fires.

There are more than a few surprises. Spoiler alert: Barnéoud invites readers to consider the implication that cells from a partner's seminal fluid might venture off into the blood and lymphatic vessels surrounding the vagina, then embed in areas of the body and brain, much like how donor cells can migrate from transplanted organs to other parts of the recipient's body.

This blurring of heredity, cells climbing back up and across the family tree, could be confusing. But Barnéoud does a beautiful job of explaining the state of this new field and its profound implications for medicine and the nature of being human – without crossing too far into hypotheticals. She dismantles the long-standing equation of "one individual, one genome" simply and enjoyably.

As a mother who once believed I shared no biology with my children, I found *Hidden Guests* both scientifically fascinating and deeply comforting. Barnéoud shows us that we all carry traces of others. She has made me eager to see how this field will develop in the future. ▮

Helen Thomson is a writer based in London and a *New Scientist* columnist

Burning bright

The battle to save the magnificent but endangered Amur tiger is a rare story of hope in conservation, finds **Adam Weymouth**

Book

Tigers Between Empires
Jonathan C. Slaght
Allen Lane (UK); Farrar, Straus and Giroux (US)

SHUTTERSTOCK/TAMIMRIDLO

An Amur tiger, also known as a Siberian tiger, tests the waters in Russia

THE Siberian tiger is an awesome animal, with "cuts of black and washes of orange", writes conservationist Jonathan Slaght, a roar like "some terrible tide", at home in the bitter winters of Russia's far east, the only tiger to share a home with bears. More precisely, geographically, it is the Amur tiger, its range fanning out from the Amur river basin, one of Asia's largest watersheds. The Amur delineates the border between Russia and China in the east, and it is the interplay of these two great empires, and the potted fortunes of their tiger, that form the spine of Slaght's compelling new book *Tigers Between Empires: The journey to save the Siberian tiger from extinction*.

There may once have been upwards of 3000 tigers spread across this vast tract of north-east Asia. Already under threat, in 1947, the Soviet Union became the first country in the world to legally protect tigers. For a time, their numbers rallied, Slaght tells us. But large carnivores have always had a particular way of mirroring human politics. The collapse of the Soviet Union impoverished people in these far-flung reaches of the country, forcing them to turn back to trapping to survive. By the end of the 20th century, tigers were severely threatened on both sides of the border, their numbers decimated by hunting, logging, the poaching of their prey and a general sense their presence was indicative of a backwards civilisation.

It was into this environment that the New Englander Dale Miquelle arrived to manage the Siberian Tiger Project. In 1992, Miquelle landed in Primorye, the furthest eastern reach of Russia, hard up against the Sea of Japan, a land of wild, untrammelled forests and rich, intact ecosystems. Slaght, who has spent decades here himself, is a wonderful guide, his descriptions of this unique landscape bristling with detail and feeling. As I read, I ached to be there, where cliffs forested with Korean pine and oak meet the ocean, and tigers prowl the beaches.

Slaght, also a field biologist, understands the obsession of those working on the project, some from the US, most Russian, who happily head into the woods for weeks to ski after tiger tracks. There is a shifting cast of both humans and tigers, and we become as wedded to the fortunes of the cats – proud Olga, brave Severina, orphaned Zolushka – as we do to the people who have dragged them back from the brink, one individual at a time. As is so often the case, changing the narrative is as important as the science. In one moving scene, a farmer recounts how he chose not to shoot Olga because of the stories Miquelle had told him about her. Coexistence was possible, Miquelle realised, because the farmer saw her now as an individual.

In an era of surging nationalism, the project, and this book, is a timely reminder of what collaboration across borders can achieve. For 30 years, Americans and Russians worked side by side, driven by a greater, shared purpose, with remarkable results. So little was known about Amur tigers when they began, and their dedication and pioneering techniques have given this magnificent animal another chance.

In 2022, Miquelle left Russia, 30 years after he began his work. Foreign-run non-governmental organisations were no longer welcome in the country. But when he left, the area of Amur tiger habitat under protection was six times larger than when he arrived. There are 500 of the tigers in the wild, twice as many as in the mid-20th century. Nothing is stable; we can take nothing for granted. But such hope is a heady tonic for today's world.

Adam Weymouth is the author of *Lone Wolf*, shortlisted for the Baillie Gifford prize

New Scientist *recommends*

Tim Boddy
Picture editor
London

It is 1995. Geocities, Yahoo! and Netscape are kings of a burgeoning internet. Spending an hour by your screeching dial-up modem on the information superhighway is thrilling. And the film **Hackers** is released, a psychedelic celebration of a burgeoning cyber culture.

The film wasn't a success back then, but it has gained a cult following in the 30 years since its debut. Rewatching it recently, I found it isn't heavy on the realism (using payphones to hack supercomputers seems a shade far-fetched).

It is, however, powered by an exhilarating techno

soundtrack, a stylish cast (including a frenetic and deeply entertaining Matthew Lillard), trippy colour palettes and supremely quotable one-liners. Its 105-minute running time is a joy and a beautiful time-capsule ode to the 1990s.

It is an oddly hopeful tale of misfits, tech and activism – as opposed to the arguably dystopian disinformation superhighway we find ourselves in today.

AXIMUM FILM/ALAMY

The sci-fi column

Deep-space brilliance A planet is about to be destroyed by the collapse of a binary star system in *Slow Gods*, Claire North's first venture into classic sci-fi. It is delightful, profound and not to be missed, says **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist* and the author of the *Sumerians* trilogy, set in ancient Mesopotamia. The final novel in the series, *Ninshubar*, is out now. You can find her at emilyhwilson.com, or follow her on X @emilyhwilson and Instagram @emilyhwilson1

DETLEV VAN RAVENSWAAY/SCIENCE PHOTO LIBRARY

It's bad luck for those living on Adjumir, which is set to be obliterated

Book
Slow Gods
Claire North
Orbit

Emily also recommends...

Book
Consider Phlebas
Iain M. Banks
Orbit

Slow Gods *reminded me many times of Banks's* Culture *novels, so this is the natural "also recommends" that arises from it. Normally, for readers new to the Culture, I recommend* The Player of Games. *But this is also a very friendly start to the series for the new reader, as well as actually being the first* Culture *book Banks wrote. It concerns a man named Horza who can shapeshift, becoming a perfect copy of anyone around him. Who would need to know more?*

CLAIRE NORTH is a successful and prolific novelist, writing under three separate names, but this is their first shift into classic science fiction, i.e. a novel with spaceships in it. I loved the title of this book, *Slow Gods*, and I loved the cover art. All of which is to say that I went in with high hopes.

It begins: "My name is Mawukana na-Vdnaze, and I am a very poor copy of myself." A great start.

After that, I got a bit lost for about 60 pages. It is an epic space opera and there were so many timelines, cultures, names... Par for the course in a space opera, obviously, but I hadn't yet bonded with the main character, a deep-space pilot with an exceptional flight record, but a poor history when it comes to not murdering people. Maybe I just wasn't in the right mood. I pushed on a bit. And then the hero, Maw, met a person called Gebre, and I was in.

I am going to leap ahead now: READ THIS BOOK. If you love sci-fi, it is for you. It is brilliant. If, like me, you are unsure at first, push on!

Since I do actually have space for a few more words here, I will elaborate on these assertions. It has been a while since I have read a piece of science fiction so purely delightful. That isn't to say it is just fun; it also manages to be both moving and profound. Oh, and it is beautifully written.

North is superb at very detailed world-building and galaxy-wide plots, but also at character and feeling. Humour, too, and in the grand tradition of Iain M. Banks, there are some lovely artificial intelligences/drones here serving as comic foils.

"*Slow Gods* also has excellent villains with bad attitudes and deadly kit, like city-killing 'blackships'"

Maw is an exceptional protagonist. It is always good, as a reader, when you have no idea what your hero is capable of, but you suspect it is something pretty dramatic. After an incident in deep space on their first mission as a pilot, Maw keeps dying... and then coming back to life. This will happen, it turns out, as long as no one is looking at their dead body or mourning them. It is unlikely that Maw is still human, although they mostly look like they are.

So, back to that meeting with Gebre... Maw has agreed to pilot a ship to Adjumir, a planet that is soon to be destroyed by the collapse of LK-08091881, a binary star system.

A mysterious god-like maybe-machine called the Slow did actually warn everyone that the star system was about to collapse and that the resulting shock wave would travel out at the speed of light and "obliterate all life with an eighty-three light-year radius". The problem is that the response to this warning across the afflicted zone has, at best, been patchy, and when Maw lands on Adjumir in its last days, there are still people there. Billions of them. All hoping that their number will be called in a lottery so they might escape.

And so Maw meets Gebre Nethyu Chatithimska Bajwahra. Gebre is currently "numberless", but they aren't focused on that. They just want to save vital artefacts so that future generations will be able to find out about the true history of Adjumir.

Gebre is a deeply appealing character and Maw falls hard for them. What might they do to protect Gebre? Or even to avenge them? Our scene is set.

I should mention there is also The Shine, excellent villains with bad attitudes and deadly kit, including near-invisible, city-killing "blackships" and super soldiers.

As mentioned: read this book!

Editor's pick

Exploring the maze of consciousness

25 October, p 36

From Robert Wright, London, UK

Robert Lawrence Khun's article on the landscape of consciousness certainly engaged my brain, so I came down on the side of thinking that is where my consciousness lies, therefore making it a biological problem.

But that still leaves a lot of questions to answer. When, at school in the 1960s, I dissected an earthworm to view its nervous system, had it been conscious? Was there a point during the evolution of animals when the nervous system developed the ability to become conscious?

One of the few things we know about consciousness is that it is "soluble" in ether. As is pain. Fortunately, the rest of the nervous system keeps working so, in the operating theatre, the heart still beats and the lungs still breathe. What does that say about the relationship between a functioning nervous system and consciousness? Are consciousness and pain somehow related? I don't know!

From Andrew Taubman, Sydney, Australia

Just as Gödel's incompleteness theorems show that no number system can fully describe itself, it seems clear from Kuhn's excellent survey of the field that whatever consciousness is, ours cannot fully understand itself. How about we just drop the whole field and concentrate on more solvable things?

From Trevor Prew, Sheffield, UK

There is no doubt consciousness requires a brain, but the brain is subservient to the gut, which evolved first. If you find this difficult to accept, stop eating for more than a day and then record what your consciousness focuses on.

Let's hear it for the horror fans

25 October, p 17

From Alisoun Gardner-Medwin, Newcastle upon Tyne, UK

Coltan Scrivner is right that horror helps us "find meaning, connection and even growth in the face of our deepest fears". It is important that the hero escapes, as Odysseus (but not all his men) did from the Cyclops and the horrors of being locked in a dark place, ahead of being eaten. I once told that story to my 7-year-old granddaughter, not realising that her younger sister was also in the room. At suppertime, it was the 3-year-old who said, "Grandma, will you tell me again the story of the giant with one big round eye?"

From Daniel Dresner, Manchester, UK

I don't recognise the profiling of horror film fans suggested by Scrivner. There is a missing category: the staple thrill of hoping – or at least trying to work out – which character survives the zombies, razor-sharp pendulums, or the end of life as we know it, rather than morbid curiosity. I'd put myself in this category and would present a control for my experiment: my wife, who hates horror films. While I'm getting my fix, she watches true-crime shockers on an adjacent screen.

Don't forget nature's less adorable animals

18 October, p 5

From Chris Arnold, Darlington, Western Australia

The two baby numbats from New South Wales are indeed "adorable". Even the adults are adorable, as my wife and I can attest from our rare roadside sighting in the Dryandra National Park in Western Australia. This gives me a neat segue into a personal observation that many people who claim to be nature lovers are in fact attracted to nature largely by prettiness. Would those same people be as driven to donate towards the preservation of at-risk but ugly creatures?

An unexpected benefit of shaving?

25 October, p 28

From Jack Barber, Stafford, UK

Carissa Wong mentions face rolling and facial massage as alleged ways of boosting our lymphatic system. I use an electric razor to shave each day, which seems to replicate her description of what one might do with a jade rolling pin. Because I am quite vigorous with my use of my electric razor, does that mean I am massaging my facial lymphatic system already, benefiting from my mode of shaving in a way I never anticipated?

Going beyond counting constants

18 October, p 40

From Robert E. Smith, London, UK

The article by Jacklin Kwan on the number of fundamental constants there are (or should be) raises an important issue that cuts to the heart of physical theory: are constants genuine features of nature, or are they artefacts of our descriptive language?

It seems to me that the answer lies not in counting constants, but in asking what role they play. Every physical "constant" serves one of two purposes: either it fixes a scale that converts between human-defined units, or it encodes a deeper invariance that remains when the units are stripped away. Only the second category deserves to be called fundamental.

The solution to the carbon-capture conundrum?

Letters, 25 October

From Eric Kvaalen, Les Essarts-le-Roi, France

David Flint is right that we need to remove carbon dioxide from the air in order to keep the world at a good temperature. The easiest way to do this, in my opinion, is to harvest biomass. The biomass can be stored as it is or transformed into another form, like charcoal, or even burned while capturing the carbon dioxide in a much more effective absorption tower.

Chilli powder vs. the cat next door

18 October, p 44

From Anne Norgate, Sheffield, UK

I have for many years used chilli powder as a (not very effective) cat repellent. But some chilli powders contain salt, which kills the plants. And, except this year, the rain eventually washes it away from the paths. So the ginger bruiser next door that ignores the ultrasound just turns its nose up at me.

Revenge never tasted so sweet

1 November, p 17

From Peter Slessenger, Reading, Berkshire, UK

I cannot help feeling that making coffee with beans from civet "scat" was originally done for revenge, bullying or a joke. My guess is that a disliked manager, or annoying colleague, was given a cup as a joke or a dare, and surprisingly, really liked it.

Want to get in touch?

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Letters sent to New Scientist, 9 Derry Street, London, W8 5HY will be delayed

For the record

Eating leafy green vegetables reduces the body's dietary acid load, meaning it makes it more alkaline (18 October, p 33).

Advertorial paid for by Gtech

How Gtech grew from garage to global

The story of a proud-to-be-British company

IF you were to run a business anywhere in the world, would you choose Worcester? Well, that's what the CEO of Gtech has done, and it's been a launchpad to global success.

Nick Grey's' innovative cordless products have sold in their millions around the world, changing the way we clean, garden and even ride bikes. And yet he's always worked from his reassuringly low-key home county.

Grey, 57, started Gtech in 2000, in his small garage in the heart of the Midlands. Over the next 16 years he – and his growing staff – moved to larger and larger premises, ending up in the sleek building – the Gtech hub – in which the company and around 200 employees are situated. And he loves it.

Is there a downside of Worcestershire? 'I love surfing when I can, but in the Midlands there aren't any beaches,' he concedes.

This cheery down to earth approach is evident in everything Nick does. He has boundless charm and enthusiasm, offering to make coffee for everyone, and chatting with his team. And his best-selling products are created from a desire to make people's lives easier and less expensive, as well as a firm goal to ensure the products bearing his company name last for years.

Creative genius

But make no mistake, the creative genius that inspired his ground-breaking cordless products is always ticking away in the background. And his Gtech innovations have brought a reliable (and cordless) freedom and order to our home and garden care.

Grey's parents ran their own business, but they always had time for the seven siblings. Grey often helped his father tinker with his car – 'he was always fixing stuff'.

'Aged six or seven I'd be helping him, and occasionally I'd do something like start it and hold the key on and he'd be shouting "What have you done?"'

From a young age, Nick always had brilliant ideas and – more importantly – the drive and self-belief to make them reality. When working for a local vacuum company in his twenties, he couldn't help constantly challenging and modifying their designs.

That's why, in 2000, he left to establish Gtech – Grey Technology – in his garage at home. Here, Grey lived on his life savings whilst creating the prototype for his first product, which involved a broom handle, and was basically glued together.

Gtech CEO, Nick Grey, above, left and far right, has a collaborative approach to innovation; employees stay with the company for many years at the Gtech hub, top right, and the iconic AirRAM 3 Limited Edition Pink, far right

'We build products from scratch that people genuinely love to use, and we keep improving them'

Nick Grey, CEO, Gtech

'I wasn't sure what I wanted to do, but I was pretty sure that I was going to make floor care cordless', he says.

The resulting SW01 cordless sweeper went on to sell in its millions around the world, and Grey was able to move from his garage to a larger house in 2005, which gave him more space to test out his inventions.

'I had about nine employees, but most importantly I had a garden, and we were developing garden tools at the time.'

In 2012 Grey created the now-iconic AirRAM for his 80-year-old mother, who was nervous about carrying a heavy vacuum cleaner upstairs.

In 2015 he developed their first eBike – a sleek, powerful machine that's sheer joy to ride up steep hills, and this year Gtech launched their DryOnic hairdryer. Rather proving that busy people are those who manage to do the most, in 2022, the company formed a partnership with Brentford Football Club.

International standards

Although the products are tested in robust lab conditions and to demanding international standards, the staff still take working models home to see how they work in real life. 'We build products from scratch that people genuinely love to use, and we keep improving them,' says Nick. 'You need a product that you can rely on, and good customer service.'

Inside the Gtech hub on the edge of Worcester, you'll find product developers, marketing teams, product creators, 3D printers, and of course – no shortage of sweepers and vacuums dotted around the offices.

But the atmosphere isn't corporate. It's collaborative.

Word on the street is that Gtech is like a big family. 'Well, I work because I love it,' Nick explains. 'I want everybody to love it. I try not to put pressure on, but try to inspire and tell people to enjoy the successes.'

Some of the workers are hybrid, but on the whole he feels that being part of the team is important. It's testimony to this that employees stay with the company for many years.

Nick adds: 'I knew I wanted to build a brand that is loyal to everyone and anyone who buys a product or supplies a product to us. My Dad ran a business and it took a lot of his emotion. It drained him. To be here 25 years later, self-funded and with a global footprint...I think he'd have been proud of what my company has achieved'.

For more information on Gtech products for your home and garden, go to gtech.co.uk

Older faster

All over the world, people are ageing more rapidly than they used to. But there are ways to turn back the clock, discovers **Graham Lawton**

A decade or so ago, I had my biological age measured. I was in my mid 40s at the time and was fit, slim and a disciplined eater. When the results came back, I was gratified to discover that I was, biologically, quite a bit younger than my age. Around six years, if I remember correctly.

I dread to think what it is now. In the intervening years, I have gained weight, stopped exercising as much, experienced multiple heatwaves and been through an extremely traumatic event, the suicide of my wife. I definitely feel all of my 55 years, and I wouldn't be surprised if I'm biologically older.

If so, I wouldn't be alone. In the past few years, scientists have discovered a troubling trend in biological ageing. All over the world, people are getting older faster. Those born after 1965 are ageing, biologically, more rapidly than people born a decade earlier, and diseases that were once considered to be a scourge of the elderly are becoming ever-more common in younger people.

"Cancers are increasing in younger age populations, people under 40 years of age have more heart attacks, more diabetes," says Paulina Correa-Burrows, a social epidemiologist at the University of Chile in Santiago. "Why? My answer is because we're ageing faster."

The reasons for this shift are starting to become clear. Some, unfortunately, are unavoidable. Many, thankfully, are modifiable. So, how can we endeavour to keep our biological and chronological ages in step?

The best way to measure how rapidly somebody is ageing is by measuring their biological age and then doing so again a few months or even years later. The most accepted tool for this, says Antonello Lorenzini at the University of Bologna in Italy, is epigenetic clocks, tests that analyse modifications to DNA. These aren't perfect – precise biological ages should be taken with a grain of salt – but they are enough for telling who, out of a group of participants, is ageing faster or slower.

Accelerated ageing

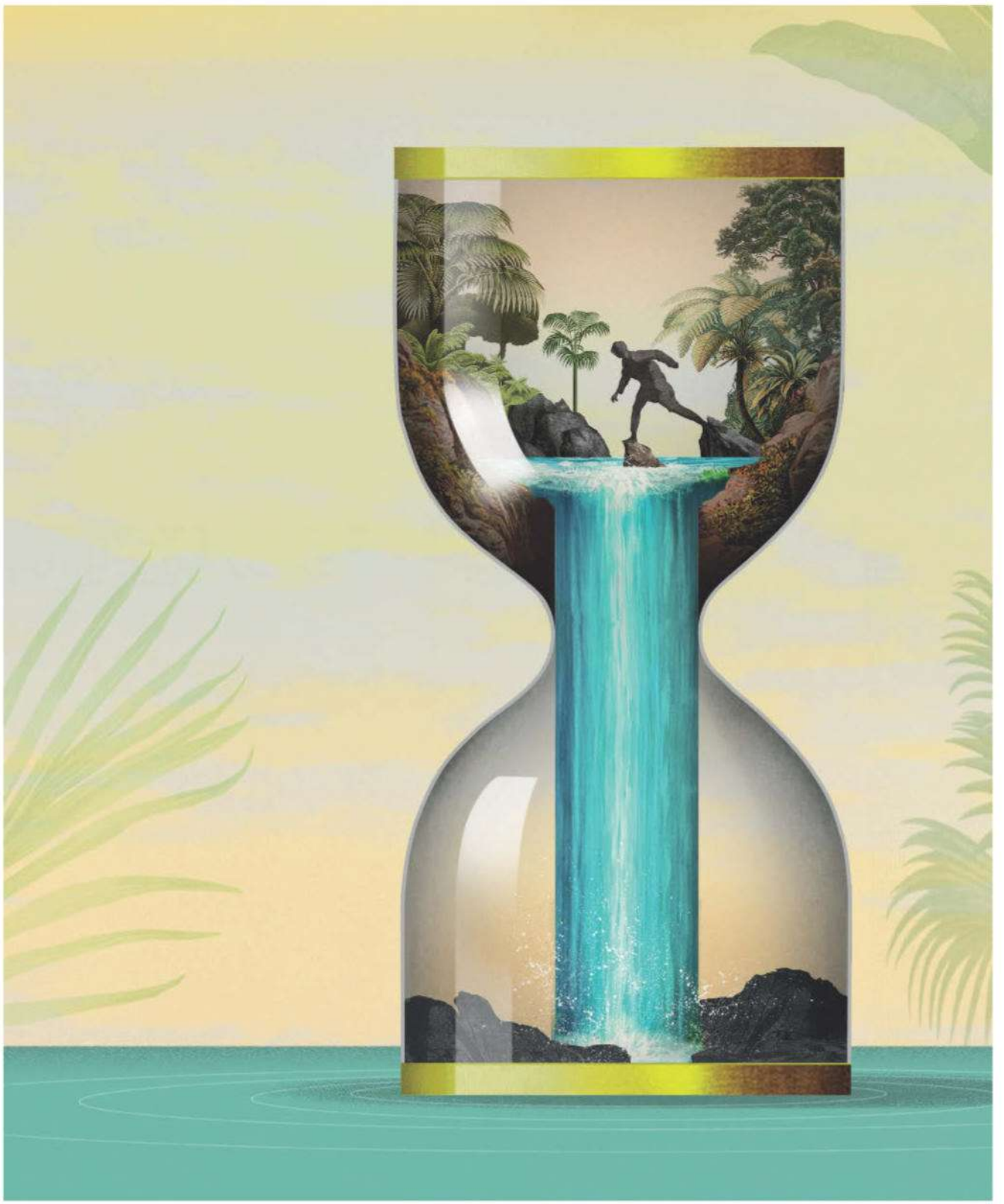
These tests recognise that chronological age – the number of years someone has lived – isn't always a good indicator of how far along the ageing trajectory they are. In fact, it can be way off. For most people, there is a reasonably good correspondence, but some people are 10 years or more younger or older, biologically, than their actual age. And unlike chronological age, biological age can go down as well as up.

The first suggestions that biological ageing is accelerating came from the world of obesity research. In 2016, a team led by Beatriz Gálvez at the National Centre for Cardiovascular Research in Madrid, Spain, noted that the biological effects of obesity overlap substantially with those of ageing. Both are hallmarked by dysfunction of the white adipose (fat) tissue, leading to metabolic conditions, widespread inflammation and damage to multiple organs, including the kidneys, bones and those of the cardiovascular system.

These effects are usually directly attributed to obesity itself. But Gálvez wondered whether the causality is more indirect: obesity leads to premature ageing, which leads to the early onset of the diseases of old age. She and her colleagues coined the term "adipaging" to capture this relationship, and proposed that "to a great extent, obese adults are prematurely aged individuals".

A couple of years later, Lorenzini and his colleagues took the idea and ran with it. They started from an influential 2013 research paper called "The hallmarks of aging", which describes nine molecular and cellular causes of age-related diseases.

Lorenzini compared these with the consequences of obesity and found strong parallels. Both obesity and ageing lead to imbalanced nutrient sensing, altered intercellular communication, disturbances in protein metabolism, dysfunction of energy-producing mitochondria in cells, and cell ›



BRETT RYDER

The heat is on

Accelerated ageing isn't just caused by obesity, stress and pollution (see main story). Climate change is also making us age faster.

Earlier this year, Eun Young Choi and Jennifer Ailshire at the University of Southern California in Los Angeles analysed biological age data from 3686 adults aged 56-plus across the US, and cross-referenced it against climate records going back six years. They found that people who had been exposed to more hot days were ageing more rapidly, with each 10 per cent increase in exposure adding 1.4 months to their biological age.

And in August, a team led by Cui Guo at the University of Hong Kong analysed data from nearly 25,000 adults in a medical screening programme in Taiwan. The researchers estimated the participants' biological age and tallied their exposure to heatwaves – defined as periods of abnormally hot weather lasting for more than 48 hours – in the preceding two years. They found that people with a greater cumulative exposure to heatwaves were ageing faster than those with less exposure.

Each four-day increase in total heatwave exposure was associated with a rise in biological age of about nine days. Totted up over a typical lifetime, this adds up to about five months.

The mechanism by which heatwaves accelerate ageing isn't clear, but we know that acute heat exposure can damage the brain, heart and kidneys, and disrupt sleep.

STR/AFP VIA GETTY IMAGES

senescence, when cells stop dividing but remain alive.

"I think that fits very well with accelerating ageing," says Lorenzini. "For many of the chronic diseases of our time, the major factor is ageing. So, of course, if you accelerate ageing, you will accelerate everything." That includes death: the life expectancy of people over 40 with obesity is reduced, by about six years in men and seven in women.

Various attempts have also been made to measure whether the biological clocks of people with obesity really do tick faster. In 2017, for example, a team largely from the University of Tampere in Finland reanalysed archived blood samples from a group of 183 people taken 25 years apart: first during the teenage years or young adulthood, then again in middle age. The participants' body mass index (BMI) was recorded when the samples were taken, so the researchers knew which of them had become obese.

As expected, those who had gained a lot of weight had aged more biologically than they had aged chronologically, some by more than 10 years. Those who had remained lean had less of a mismatch. (The team also wanted to see what had happened to the rate of ageing in people who had lost weight, but there weren't enough people in this category to do the analysis.)

Impacts of obesity

A similar study in women in their 20s, 30s and 40s also found that a higher BMI was associated with an older biological age, with each rise of 1 kilogram of weight per metre of height squared adding about 1.7 months. Another discovered that increased biological age was associated with various measures of obesity – BMI, waist-to-hip ratio and waist circumference – in women aged 35 to 75. Those with a BMI of 35 or more, putting them firmly in the obese category, were on average 3.15 years biologically older than women of the same chronological age who were a healthy weight.

None of these studies, however, proved the direction of causality. It is possible that obesity accelerates biological ageing, but also that an increase in biological age somehow leads to obesity.

Last year, researchers in Beijing teased these possibilities apart. They reanalysed data on tens of thousands of people who had been enrolled in a previous study and whose BMI, waist circumference and waist-to-hip ratio had been recorded on several occasions, along with five measures of their biological age. Applying a statistical method that can indicate the direction of causality, the researchers showed that obesity causes accelerated ageing compared with people of a healthy weight, to the tune of around three years.

These studies all point in the same direction, says Lorenzini. "We are moving from hypothesis to data. The data is piling up."

The latest addition to this pile comes from the lab of Correa-Burrows and her colleagues at the University of Chile. They piggybacked on a research project called the Santiago Longitudinal Study, which started in 1992 and followed around 1000 people from birth up to their late 20s, originally to study the effects of nutrition on health in children and young adults.

Correa-Burrows and her team recruited 205 participants who had made it all the way through the study. They were aged between 28 and 31 and comprised three groups: those who had maintained a healthy weight throughout life, those who had been obese since adolescence and those who had been obese since early childhood. There were already masses of data on these people, including their BMI throughout the study,

People born before 1965 are ageing, biologically, more slowly than those born more recently

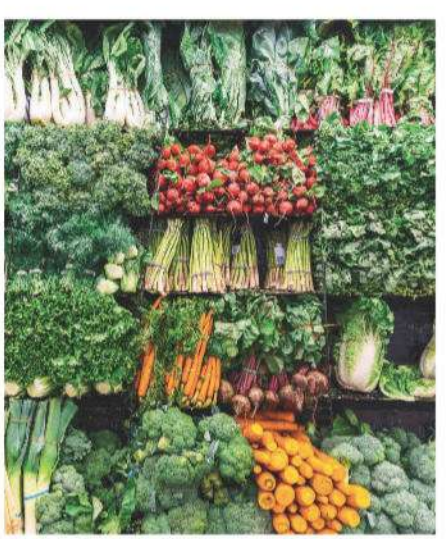
but Correa-Burrows also used epigenetic clocks to measure their biological age.

What she found was very clear. Those in the healthy weight group had, on average, biological ages slightly lower than their chronological age. But those in both obese groups were biologically older than their chronological age. This was by an average of 4.2 years in the obese-since-adolescence group and 4.7 in the obese-since-childhood group. A few had biological ages over 40.

"We were expecting to find that, but we never expected the magnitude of difference that we saw in some individuals," says Correa-Burrows. "Some of them had a 50 per cent gap between their biological age and the chronological age, which is huge." It is now generally accepted in geroscience circles that obesity speeds up the ageing process, she says.

Accelerated ageing is also attracting the attention of researchers outside the obesity field. Premature ageing is a well-known phenomenon among adult survivors of childhood cancer, who often become frail and die early as a result of the after-effects of their illness and treatment. They are also at a higher-than-average risk of developing an unrelated cancer in later life. That may be because they are genetically predisposed to cancer, but this can't fully explain the elevated risk.

> "Some people are 10 years or more younger or older, biologically, than their actual age



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DHIRAJ SINGH/BLOOMBERG VIA GETTY IMAGES

Avoiding obesity through healthy eating or even weight-loss drugs can help slow biological ageing

Last year, Paige Green at the US National Cancer Institute in Bethesda, Maryland, had a brainwave. Cancer is typically a disease of old age, and the survivors of childhood cancer were ageing prematurely. Maybe they were more vulnerable to cancer because they were biologically older than their chronological age. And not just that: accelerated ageing in the general population might also explain the rise in early-onset cancer, heart failure and strokes.

The cancer factor

"Cancer used to just be considered a disease of ageing," says Jennifer Guida, an independent researcher who was formerly Green's colleague. "Now people are being diagnosed with colon cancer in their 30s, breast cancer in their 30s. Why is that? Perhaps some of the processes of ageing are acting earlier and causing ageing to accelerate, which then causes early-onset cancer."

Green, Guida and their colleague Lisa Gallicchio wrote the idea up in the journal JAMA Oncology as a challenge to others to test it. "We put it out there as a hypothesis," says Guida. "Maybe somebody will run with it and do the work to show that this is true, or disprove it." The way to do it would be to measure the biological ages of a large number of people already enrolled in a large scale study and tally that with early-onset cancers, she says.

In fact, a team has already done that. Last year, Ruiyi Tian at Washington University in St. Louis, Missouri, told the American Association for Cancer Research's annual meeting in San Diego, California, that she and her colleagues had analysed blood samples from nearly 150,000 people stored in the UK Biobank, looking for signs of accelerated ageing. The participants were aged between 37 and 54 when they had their blood taken.

Measuring their biological age revealed that those on the younger end of the age spectrum, who had been born after 1965, were 17 per cent more likely to show signs of accelerated ageing than the older ones, born between 1950 and 1954. The researchers also found that accelerated ageing increased the risk of early-onset cancers of the lungs, ›

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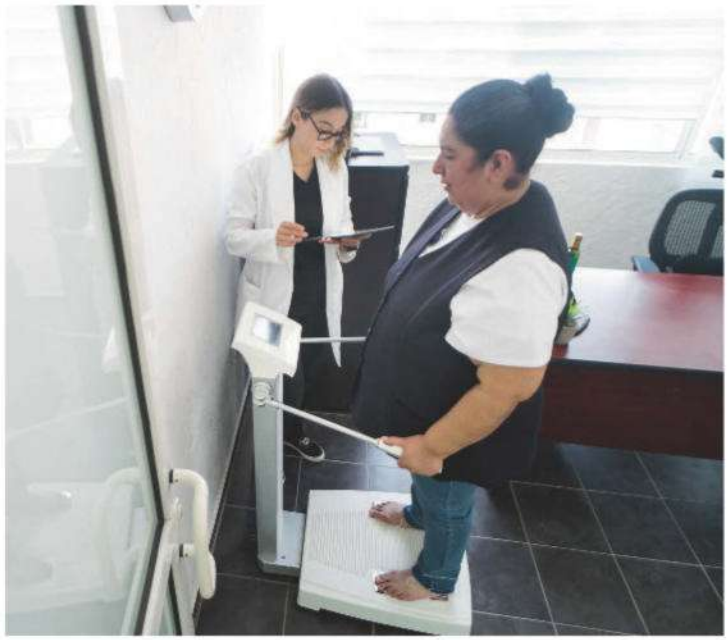

ALDOMURILLO/GETTY IMAGES

The biological clocks of people with obesity tick faster

gastrointestinal tract and uterus.

"Accumulating evidence suggests that the younger generations may be ageing more swiftly than anticipated," Tian told the association's press office at the time. (The results haven't been published in a peer-reviewed journal and Tian and her supervisor didn't respond to requests for further information.)

All in all, it seems we have created a world that not only promotes obesity – known as the obesogenic environment – but also ages us. Perhaps we need a new shorthand for it. I suggest the "senesogenic environment", derived from the Latin verb senescere ("to grow old").

So, if younger people are ageing more rapidly, what is the cause? Obesity is the main one. "We have a huge obesity problem in places that have a Western-type diet," says Guida. Obesity rates in 5 to 19-year-olds increased 1000 per cent between 1975 and 2022, according to the World Obesity Federation, and children with obesity tend to remain obese as adults. "Obesity's prevalence has kept rising despite governmental efforts to try to reduce the rates, and by 2030, 1 billion people in the world will be obese," says Correa-Burrows.

The mechanism by which obesity leads to accelerated ageing is a bone of contention. It may be that carrying around too much fat is a direct cause, possibly because it promotes inflammation. "When you have chronic inflammation, it triggers these biochemical ageing signatures," says Correa-Burrows.

Alternatively, it could be that flooding the body with excess calories causes both obesity and ageing. Lorenzini favours this hypothesis, noting that many of the pathways associated with the ageing process are involved in nutrient sensing. It is well established that switching these pathways off in animal models – using drugs or caloric restriction – activates repair processes and retards ageing. Maybe people with a high-calorie, morning-noon-and-night diet chronically stimulate the pathways, so their body never has a chance to fix the damage that leads to ageing.

Obesity isn't the only culprit, however. "Anything that increases hormones related to stress, particularly cortisol, is going to have an adverse effect in terms of your biological ageing rate," says Correa-Burrows. "Pollution has this effect. Early childhood adversity also. Trauma." Exposure to heatwaves has also been found to speed up biological ageing (see "The heat is on", p32), maybe because it activates stress hormones.

> "Exercise is probably the biggest thing that you can do to slow your ageing

People are also more sedentary than they used to be, says Guida. "All these things feed into each other to create this perfect storm."

So how can you avoid becoming old before your time? "A lot of it comes down to lifestyle change," says Guida. "Exercise is probably the biggest thing that you can do to slow your ageing. We know caloric restriction works too, but it's not always feasible for everybody. Sleep is a great way to promote restoration and repair. And avoiding alcohol and smoking."

Down the road, drugs might also help. The type 2 diabetes medicine Ozempic, a GLP-1 receptor agonist, was recently shown to slow the rate of ageing, and another study found that this drug family is also linked to a lower risk of obesity-related cancers. But we don't yet know enough about the long-term effects to recommend them as an anti-ageing strategy, says Correa-Burrows.

The good news, however, is that even if your biological clock has outpaced your chronological clock, lifestyle changes can throw it into reverse. "There are ways to synchronise both clocks or even put your biological clock below your chronological clock," says Correa-Burrows. "Most of the interventions are based on changes in your lifestyle: exercising and changing your diet."

OK, I get it. Time to lose some weight and get active again. I doubt I can get back to being biologically six years younger than my age. Fifty-five would suit me just fine, though. ▮

Need a listening ear? UK Samaritans: 116123 (samaritans.org); US 988 Suicide & Crisis Lifeline: 988 (988lifeline.org). Visit bit.ly/SuicideHelplines for other countries.

Graham Lawton is a staff writer at *New Scientist*

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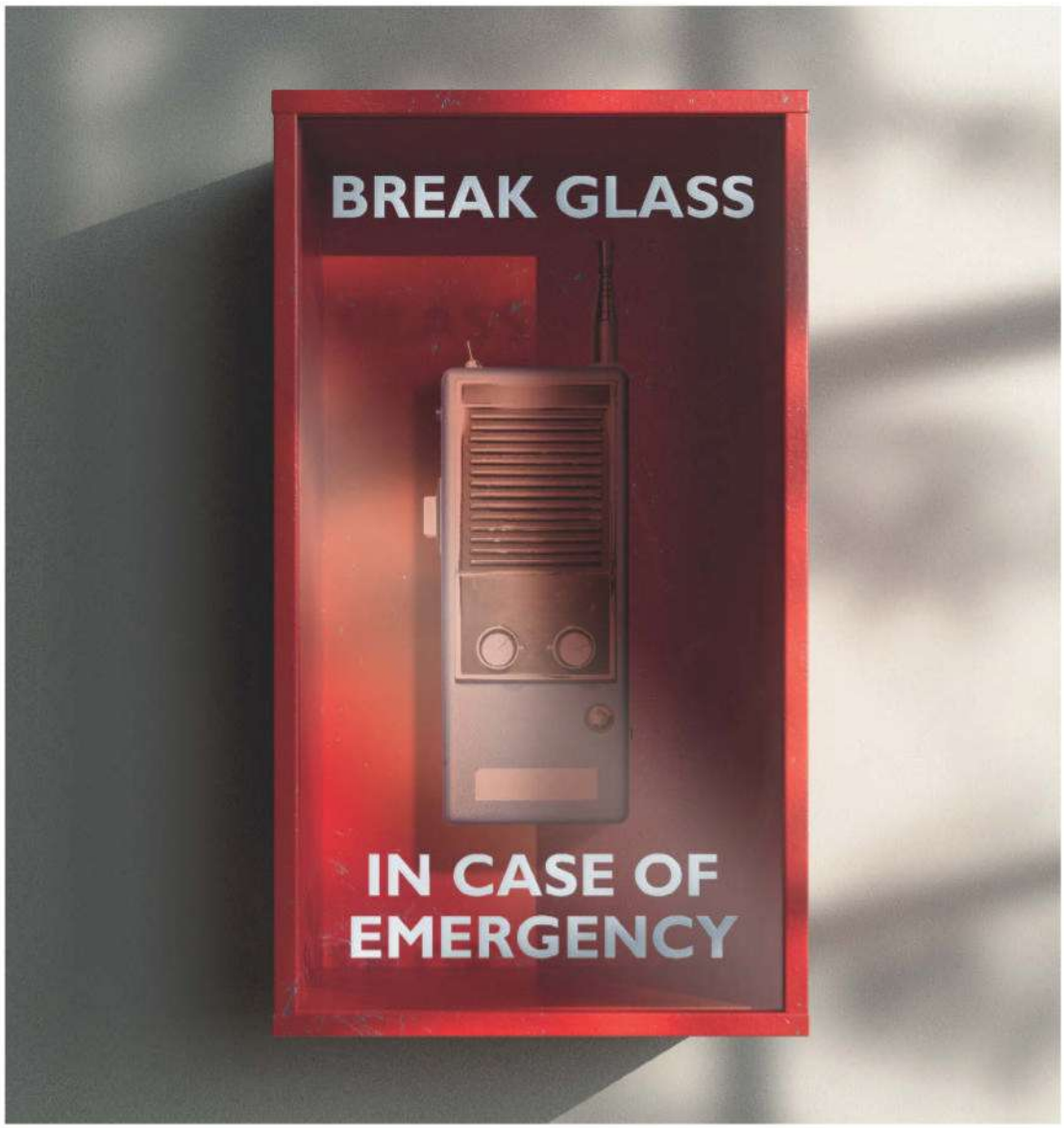


JOHN SMITH/GETTY IMAGES; ADOBESTOCK

Rebooting from scratch

What happens if the internet completely fails? With no clear official plans, a team of hackers is preparing their own backup. **Matthew Sparkes** meets them

VLADIMIR Lenin is said to have warned that all societies are three square meals from chaos. But in the modern world, it is only a Wi-Fi signal that separates us from anarchy. Every aspect of our lives is reliant on computers and the internet, and when they fail, they do so with disorientating speed.

This became abundantly clear during power cuts across Spain and Portugal earlier this year. Traffic signals went dark and roads clogged, while emergency services couldn't take calls and commerce ground to a halt. Even telecom networks in Morocco and Greenland suffered because they rely on servers in Spain.

Surely governments around the world have well-oiled plans in place to deal with catastrophic internet outages? They don't appear to, says Valerie Aurora, a legend of the tech world known for her contributions to open-source operating system Linux. Concerns that no such plans exist have driven Aurora and about a dozen cybersecurity experts, hackers, radio hobbyists and lawyers to a 15th-century café in Nieuwmarkt square in Amsterdam, the Netherlands, on a radiant Sunday afternoon. I've come to meet them, and have no idea what to expect.

What I discover is a group of dedicated volunteers drawing up their own plans to reboot the internet in the event of a disaster. The world's only Internet Resiliency Club (IRC) is currently stress-testing the technology that could restore network connectivity – and enjoying coffee and cake while they do so.

"My nightmare is that something goes wrong and I just can't contact anyone," says Aurora. "I'd like to be part of helping get things running again."

The internet is perhaps the most complex, fragile and vital machine that humanity has ever created. Over the decades, it has become crucial to almost every component of our lives: global banking, the military, phone networks and even water and electricity utilities. But our greatest tool is also under increasing threat. Climate change can cause flooding that takes power grids and data centres offline. Political tension and the wars that sometimes ensue can lead to attacks that damage physical infrastructure and sever transmission lines. Hackers, meanwhile, launch cyberattacks every day. And even if we avoid all of these problems, there is the ever-present threat of a powerful solar storm on the scale of the Carrington event, which electrified telegraph wires and shocked operators in 1859.

A fragile backbone

"If something like that were to happen today, it would potentially take down the entire internet," says Trammell Hudson, a self-proclaimed hacker and software developer who is also a member of the IRC. "The sun has an unimaginable amount of power."

But there doesn't seem to be any official plan to repair a severely damaged internet, says Aurora. "If there is one, it's successfully being kept secret from everybody who should know and who would implement it."

Enter the volunteers of the IRC. Inspired by tales from colleagues in Ukraine about the bravery and guile required to keep systems online in the face of cyber and physical aggression from Russia, the 150 or so IRC volunteers are drawing up plans that they think could help restore a broken internet.

With such an ambitious goal, you could be forgiven for wondering where they even begin. The answer, I discovered when I met some of the IRC volunteers in Amsterdam, is by thinking small. Although the internet is a global network, its capacity to connect businesses and people across a city is important, too. As such, the immediate focus of the IRC is to construct a local service that could bring Amsterdam back online, particularly when it comes to allowing utility companies and other important services to resume operations.

Doing so requires a change of mindset, according to IRC volunteer Joe Abley. He works for a large tech firm, fending off multiple large-scale cyberattacks every single day. He says this is possible only because he can quickly and easily communicate and coordinate with software engineers from different companies or even in different countries. Email, video calling and instant messaging are vital tools ›

that enable such communication and would be the obvious way for Aurora and her band of volunteers across Amsterdam to work together to bring the internet back online. But, of course, all of these tools run on the internet, so none of them would be working in such a scenario.

"It's the bootstrap problem," says Aurora. "How do you get a connection back when you have no connection and everybody who can fix it has no plan, doesn't know where to meet, doesn't know where to go?"

Clearly, the IRC team will have to rely on different tools. But even those may be useless without a detailed plan. For instance, Aurora spoke to computer experts in the wake of this year's widespread power cuts in Spain and Portugal. She learned that some had satellite phones, a great way to communicate over long distances in the absence of the internet or a working power grid. Unfortunately, the specialists in Spain lacked hard copies of the names and numbers of the people they needed to contact to work out how to restore power – and, of course, they couldn't look these up on their computers. So, their satellite phones were of little use.

Aurora and her team are keen to learn from examples like this. They are working on a low-cost solution to the communication problem and devising a plan to put that solution into action. I'm afforded a glimpse of how they are progressing when several group members take out tiny electronic devices and plonk them on one of the café tables. Some of them have bare printed circuit boards with chips and antennas exposed, while others are housed in neater 3D-printed enclosures. They aren't much to look at, but the IRC volunteers think they could be vital if the internet broke.

Valerie Aurora founded the IRC to create backup plans for when the online world goes dark

MATTHEW SPARKES

Radios of last resort

These devices come from a different volunteer-run project, Meshtastic. They were designed to help people communicate in situations where there is no access to traditional internet services, which is why they caught the eye of the IRC volunteers. The Meshtastic technology uses unlicensed parts of the radio spectrum to send short text messages and snippets of data. You certainly couldn't host Zoom calls with them, but in an emergency, they could be enough to convey what's needed. And although each device has only a limited range, in sufficient numbers they can link together to form a network – a mesh – across an entire city. The radios can broadcast, receive and rebroadcast messages so that information can travel from one end of the network to the other.

The best part is that the Meshtastic devices require so little energy that they can be powered indefinitely by small solar panels, meaning they could help small-scale networks operate even if the power grid collapses.

On paper, the Meshtastic radios sound ideal. But the IRC volunteers need more proof than that. They are now stress-testing the technology to see if it meets their expectations in the real world.

Someone switches on a Meshtastic device, and I see a bit of chatter come through – a string of "Can you hear me?" text messages from enthusiasts elsewhere in Amsterdam who are using the technology for their own hobbies. At one point, a message pops up asking if there are any raves planned for this week in the city.

The world's internet connection hinges on vulnerable pieces of infrastructure, like undersea cables (above right) and local power grids. Outages, like the one in Spain earlier this year, caused blackouts (right) and chaos at bus stops (above left)

It seems promising to me, but the IRC volunteers haven't yet decided whether the Meshtastic radios will form part of their plans. They look – and are – tricky to use, even for the tech-savvy. "These are very much for the hobbyists and the hackers. This is not a commodity, you know, pick-it-up-and-just-use-it kind of thing," says Hudson.

The IRC volunteers are also uncovering the technology's limitations. For instance, some manufacturers claim each device has a range of up to 10 kilometres, but IRC testing shows that in cities with tall buildings and plenty of chatter over the airwaves, the range is closer to just a few hundred metres. This means that to operate somewhere like Amsterdam, hundreds of radios would have to be attached to the sides of buildings throughout the city. Getting permission to install so many would be tough, particularly since Amsterdam has many historic buildings that are protected by stringent planning rules.

Hudson is keen to experiment further with the Meshtastic tech. He is trying different ways to transmit data, perhaps sacrificing capacity for speed or vice versa, in a bid to find the most reliable way to communicate.

JORDI BOIXAREU VIA ALAMY STOCK PHOTO

DAVID FLEETHAM VIA ALAMY STOCK PHOTO

ANADOLU VIA GETTY IMAGES

"This is the world we're in... Cybersecurity is a complete disaster."

With that trade-off between reliability and usability in mind, other IRC volunteers are exploring how easily they can coordinate and work together using nothing but Meshtastic devices. One simple test might involve asking a few dozen IRC volunteers to leave home without their phones and arrange an impromptu picnic using nothing but the radios, deciding on a location and arranging who brings what food and drink.

"No backup is any good unless you test it," says Abley. "If we're relying on these to communicate, and we'd practised, and we didn't just leave it until the last minute to try and test all these things, then I think it would be great."

Abley knows people volunteering their time in Ukraine, trying to keep networks there up and running. The country's military is heavily reliant on billionaire Elon Musk's Starlink satellite constellation, but concerns about the possibility of catastrophic network failures mean independent solutions are seen as key – although the ongoing war makes it difficult to plan and test options on the ground in Ukraine.

Nevertheless, it should be possible for others across the world to learn from the IRC volunteers' experiences in Amsterdam. Aurora is hopeful that their efforts will encourage experts elsewhere to form their own local IRC groups. The more of these groups that are out there, she argues, the easier it will be to reboot local networks and begin to link them up – which would help connect larger numbers of experts who could work together to bring back even more internet services.

The big unknown is whether any of the IRC's plans will ever be needed. Group members accept that governments may be developing their own plans, keeping them secret because they contain sensitive information that would be dangerous in the hands of nefarious actors. This could be one explanation for why *New Scientist* received no reply after contacting the UK's Government Communications Headquarters to ask about its resiliency plans – although the organisation did recently recommend that companies in the UK should keep paper copies of their plans to deal with cyberattacks. Aurora has doubts that such plans are really in place, though, particularly because they would be expensive to draw up.

If anything, she suspects that the internet is becoming less resilient. Recently, the Trump administration decided to dismantle the US Cybersecurity and Infrastructure Security Agency, which ran programmes that monitor foreign attempts to break into critical infrastructure like voting systems and electrical grids.

Ticking time bomb

Even attempts to strengthen the resilience of the internet are met with resistance. Aurora says she recently attended a meeting with government officials and hardware-makers about the European Union's Cyber Resilience Act, which came into force last year and is designed to improve internet security across Europe.

She says an employee from a hardware-maker was arguing about a clause that proposes a future ban on the sale of devices with known security flaws. The employee wanted to add a loophole that would ban only the devices that were listed as vulnerable on EU databases – meaning that it would still be possible to sell those that had been identified as vulnerable by experts elsewhere in the world but had yet to be added to EU lists. "This is the world we're in," says Aurora. "Cybersecurity is a complete disaster."

It is this knowledge that spurs the IRC volunteers on, encouraging them to meet in their free time to take on the important work that they suspect the authorities are unwilling or unable to do. And although the task facing them is daunting, they refuse to believe it's impossible. If the internet ever does succumb to severe damage, we may all find out whether they are correct. ▮

Matthew Sparkes is a science and technology reporter at *New Scientist*

Shaking the family tree

Palaeoanthropologist **Christopher Bae** speaks to Michael Marshall about his proposals for two new species of prehistoric human – and why he thinks the rules for naming them are flawed

IT IS fair to say that the family tree of ancient humans is not written in stone. Just take the case of the Denisovans, the enigmatic ancient humans who were, until recently, known only from a few fragments of bone. In June, molecular evidence indicated that a mystery skull from China was actually a Denisovan. These ancient people suddenly had a face.

Or did they? Anthropologist Christopher Bae at the University of Hawai'i at Mānoa is one of those who disagrees with the conclusions. He still feels the skull in question belongs where it was previously, that is, attributed to a species called *Homo longi*. In fact, Bae is at the heart of the tumultous debates about what our family tree ought to look like. In the past five years, he and his colleagues have suggested we add two ancient human species into the mix: *Homo bodoensis* and *Homo juluensis*.

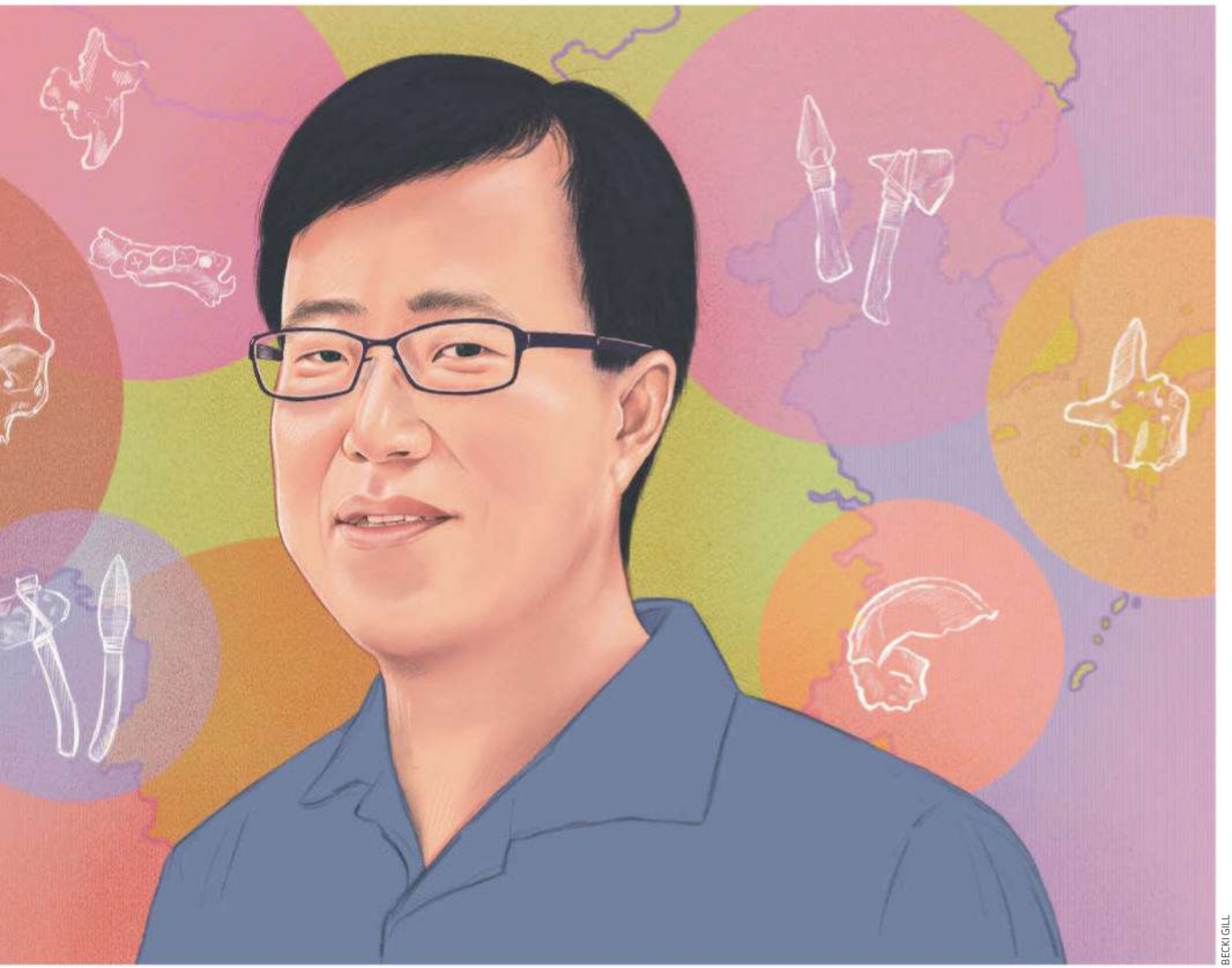
Both suggestions caused controversy, partly because Bae and his colleagues wilfully broke the formal rules that govern how species are traditionally named. Bae is unrepentant, however, arguing that the rules themselves have become fossilised relics that make no allowance for removing species names that are now considered offensive, or for ensuring that names are easy for everyone to pronounce. He spoke to *New Scientist* about all this – and how his interest in human evolution was sparked by the mysteries in his own origin story.

Michael Marshall: What was it that first drew you into studying ancient humans?

Christopher Bae: The basic goal of palaeoanthropology is to reconstruct the past, even without all of the pieces of the puzzle. Being originally adopted, where the first year of my life is a complete blank, the field resonated with me. In my own case, I was born in Korea, then I was abandoned when I was about a year old, and I lived in an orphanage for about six months before being adopted by an American family.

When I was an undergraduate student, I was able to go to Korea for the first time on an exchange programme, and during that trip I went to the adoption agency where I came from. I asked the manager whether there was any chance that I could actually find my biological parents. They said, to be honest, your Korean name is not real and your date of birth is not real. You shouldn't even bother trying. There's absolutely no chance. I kind of gave up at that time.

So I was interested in my own roots and I couldn't figure out how to find them. But then I took an introduction to biological anthropology course, and I found a field where I could actually explore origins. It's kind of like building my own origins.



BECKI GILL

Two species that often pop up in discussions about our direct ancestors are *Homo heidelbergensis* and *Homo rhodesiensis*. But in 2021, you were part of a team that proposed replacing them both with a new species named *H. bodoensis*. Why?

My colleague, Mirjana Roksandic [at the University of Winnipeg, Canada], and I organised a session at a 2019 anthropology conference focused on the *H. heidelbergensis* question. There was general agreement that *H. heidelbergensis* is what we call a "wastebasket taxon" because anything from the Chibanian Age [775,000 to 130,000 years ago] that doesn't clearly belong to *Homo erectus, Homo neanderthalensis* or *Homo sapiens* tended to be assigned to it.

So what happens to the *H. heidelbergensis* fossils that do constitute a distinct group of hominins. Do they get a new name?

If we get rid of *H. heidelbergensis,* the next name, based on the rules of priority, is *H. rhodesiensis*. But that species was named after Northern Rhodesia, the old name of present-day Zambia, which itself was named after Cecil Rhodes. Now, do we really want to name the potential ancestor of modern humans after a known colonialist like Rhodes? So, when we were putting that paper together, we said, you know what, we'll come up with a new name, and we'll name it after Bodo [a 600,000-year-old skull from a site in Ethiopia].

What was the reaction to your paper?

When it went out for review, half the reviewers said, this has got to be published because we have to have this discussion out there. The other half of the reviewers said, this is ultimate garbage, it should not be published. Not surprisingly, there was a back-and-forth as soon as the paper came out. ›

"The basic goal of palaeo-anthropology is to reconstruct the past without all the pieces of the puzzle"

CHRISTOPHER BAE

The Xujiayao site in northern China, where fossil hominins were found

Is there any emerging consensus yet?
We had a workshop in 2023 in Novi Sad in Serbia. We had about 16 or 17 palaeoanthropologists working on this topic. We all agreed that *H. heidelbergensis* has become a wastebasket taxon. The other major conclusion was that *H. rhodesiensis* should be removed from circulation because of Rhodes's colonial history. In fact, only one of the palaeoanthropologists in attendance thought *rhodesiensis* was not problematic.

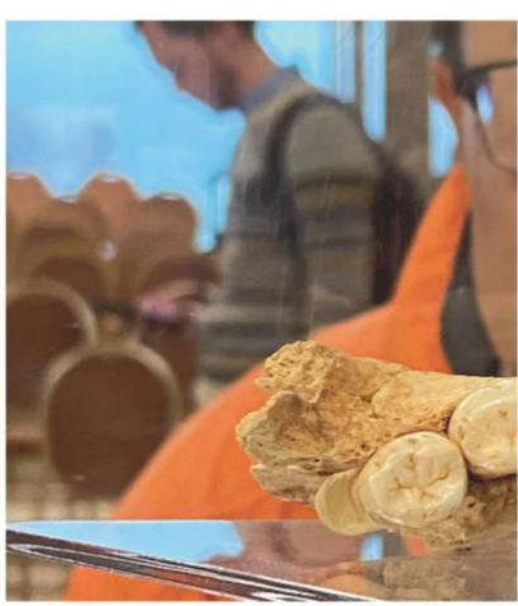
It is the International Commission on Zoological Nomenclature (ICZN) that ultimately judges cases like this. Has it responded to your *H. bodoensis* argument?
The ICZN published a paper in the *Zoological Journal of the Linnaean Society* in 2023, a pre-emptive strike, and they said: We're not going to remove any names from circulation where there may be ethical issues. We actually ended up going down a rabbit hole as a result of this, and challenging the ICZN. *Editor's note: The ICZN's 2023 statement recognised that scientific names might cause offence, but said it is outside the scope of the commission to assess the morality of persons honoured in eponyms. It also emphasised the importance of zoologists following its code of ethics when naming new species.*

Are species names really important enough to fight over?
Yes and no. For instance, there's a beetle from a few caves in Slovenia. In the 1930s, an Austrian entomologist [Oskar Scheibel] said, I'm going to name this as a new species, after Adolf Hitler. Nowadays, the beetle [*Anophthalmus hitleri*] is a hot product as a keepsake. On the black market, people are selling them because a lot of neo-Nazis want to collect them. It's eventually going to lead to the extinction of these poor innocent beetles, who haven't done anything to bother anybody.

What's the alternative?
I would say, talk with your local collaborators and find a species name that would be acceptable for them, because they're the ones who are going to have to deal with it and live with it on a regular basis. I would hope that we stop using people's names to name species or we'll continue to run into problems down the road. I think that's the direction that we're going to go – and change is in the air. The ICZN is trying to change how they can attract members from the Global South and give them more of a voice. And some other major associations such as the American Ornithological Society have recently voted to remove egregious species names from the biological organisms they study.

> "When we looked at the skull, we said, wow, this looks really, really different"

THILO PARG CC BY-SA 3.0



Above: Replica of a Denisovan molar, originally found in Denisova cave in Siberia in 2000. Right: Bae examines a human fossil found in Serbia that may belong to *Homo bodoensis*

You fell foul of the ICZN rulebook again last year, regarding some ancient human fossils from a site in northern China called Xujiayao. What's the story there?
Researchers found a bunch of different hominin fossils at that site in the 1970s, representing more than 10 individuals, but the fossils were all separate pieces. My colleagues and I, including Xiujie Wu [at the Chinese Academy of Sciences], worked on these fossils. Wu actually did a virtual reconstruction of the posterior part of one skull. And when we looked at it, we said, wow, this looks really, really different from other similar-aged hominins.

What sort of differences are we talking about?
Size and shape differences. Our average cranial capacity is about 1300 to 1500 cubic centimetres. These guys have a cranial capacity between 1700 cm^3 and 1800 cm^3 – so much, much larger than your average human. Furthermore, based on a shape analysis, it was clear that the Xujiayao fossils – and fossils from a nearby site named Xuchang – consistently fell away from the other fossils and grouped together. That's what led us to naming a new species.

CHRISTOPHER BAE

> "I would hope that we stop giving species people's names, or we'll keep running into problems"

But the name you chose was controversial. Can you explain why?
Where species names actually come from is quite fascinating. In this case, we could have named it after Xujiayao – which is the type site – and then added "-ensis" at the end, making it *Homo xujiayaoensis.* This follows the ICZN rules.

And in Latin, that means "Homo belonging to Xujiayao". But you didn't like that option?
The problem is, only people who speak Chinese will be able to pronounce it, let alone spell it correctly. Names actually mean something. You need to be able to pronounce and spell them. So we came up with "*julu*", which literally means "big head".

If we follow the ICZN rules, though, then we are required to add an "i" at the end, making "*Homo jului*". However, in our view, again, people would not be pronouncing it correctly unless they understood Chinese. Some people might say "*julu-eye*", others would say "*julu-ee*". This is why we chose *Homo juluensis*.

How does your new species relate to the mysterious Denisovan humans, who lived in what is now East Asia during the Stone Age?
If you look at the second molars from the Denisova cave in Siberia and the second molars from Xujiayao, they look almost exactly the same. You could actually take the Xujiayao molar and put it in Denisova, and then take the Denisova molar and put it in Xujiayao, and few people would know the difference.

But earlier this year, another group of researchers linked those same Denisovan fossils to a different ancient species from China called *Homo longi* – and that idea seems to have gone down well with many researchers.
In China, actually, most palaeo people agree with our *H. juluensis* argument. A lot of Westerners that are familiar with the Chinese record also tend to agree.

But what about evidence from the skull that appeared in June? Researchers extracted ancient proteins from a skull attributed to *H. longi* and found a match with proteins extracted from known Denisovan fossils.
When you talk to most geneticists, they say that you could probably discount the protein analysis for species-level identification. You can get at a broader level, like a cat and a dog, but it's really hard to identify distinctions at a finer level.

Would you still accept *H. longi* as a valid species?
Oh yeah, I actually like *H. longi* and the fossils assigned to it. The debate revolves around what other fossils, if any, should be assigned to *longi* or whether some of these other fossils should be assigned to *juluensis*. It is interesting nowadays that the *longi* supporters seem to be trying to lump everything into *longi*, despite clear morphological variation in the Chinese fossils.

I've seen a few strongly negative reactions from other palaeoanthropologists to some of your research. How do you and your colleagues respond to that?
At this point in our careers, we've developed thick skin. ▮

Michael Marshall is a science writer and author of *The Genesis Quest*

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
What's the best way to pack a suitcase to fit the most clothes? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
The fault, dear Brutus, is not in our stars, but in Shakespeare p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Stargazing at home

Time for a shower

A new moon on 20 November means there is a great chance to spot the Leonid meteor shower this year, says **Abigail Beall**

Abigail Beall is a features editor at *New Scientist* and author of *The Art of Urban Astronomy*. Follow her @abbybeall

THERE is something magical about watching a meteor shower. Part of this is down to the shower's unpredictability – the conditions can appear perfect, yet you may still end up underwhelmed, especially when you are promised hundreds of meteors an hour. But then there are times when you gather friends around to enjoy the show together, and you are happy to see just a handful of shooting stars.

This year, the Leonid meteor shower is timed almost perfectly with a new moon, giving us a wonderful chance to see plenty of meteors zipping across the sky. There may not be hundreds each hour, but I would still recommend trying to have a look.

Meteor showers happen at about the same time every year, because they coincide with Earth's path around the sun bringing us through patches of debris left behind by passing comets and asteroids. This causes more pieces of dust than usual to enter our atmosphere, where they burn up in the bright flashes of meteors.

The Leonid meteor shower comes from the dust left behind by Tempel-Tuttle, a comet 3.6 kilometres in diameter that orbits the sun every 33 years. When it comes close by, the Leonids become a meteor storm rather than a meteor shower, with thousands of meteors visible every hour. The last storm was in 2002, so we can't expect another for 10 years.

Even so, there should be a great chance to see meteors like the one pictured if you are lucky enough to have clear skies. The Leonid meteor shower starts on 6 November and will be active until the end of the month, but the peak is on the evening of 17 November, into the morning of the 18th. November's new moon is on the 20th, so on the evening of the shower's peak, it will be a very thin waning crescent. The best time to look will be just after midnight local time, wherever you live in the world. Compared with other meteor showers, the Leonids tend to have a gradual peak, so it is worth looking on the days around the 17th if you have a clear night on either side.

WALTER PACHOLKA, ASTROPICS/SCIENCE PHOTO LIBRARY

Meteor showers are named after the constellation the meteors appear to come from in the sky, but this doesn't mean you have to find Leo to see the Leonids. Leo is an easy constellation to spot, though, and is visible from most of the world, other than extremely southern latitudes. To find Leo, look for its iconic backwards question mark, or sickle pattern. It will be near the Plough, or Big Dipper, in the sky. If you need extra help finding it, you can use an app on your phone.

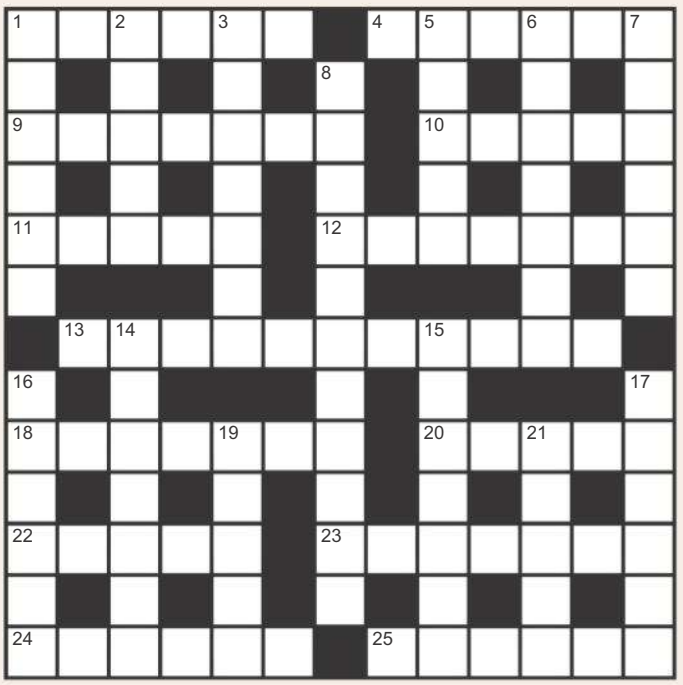
To best enjoy a meteor shower, first get warm and comfortable. The show can involve sitting still for a long time, so I recommend a hot water bottle and a way to look up without hurting your neck. Get as far from light pollution as you can. But if you want to look from your house, turn off the lights and let your eyes adjust. Enjoy! ▮

Stargazing at home appears monthly

Next week
Mathematics of life

These articles are posted each week at newscientist.com/maker

Cryptic crossword #174 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Very small length, such as 2 × 4, say (6)
4 Murderer coming back in form of B_3 (6)
9 Effect of damp in conflict with paper (7)
10 Chinese TikTok embracing return of flying toys (5)
11 Put "10" in same unregulated tests (5)
12 Rootlet that sounds awesome! (7)
13 Our shop twice destroyed, meaning incendiary element is involved (11)
18 One in pack given marching order? (7)
20 Write rate on case of bureau to complete paperwork (5)
22 Experiencing regret, having initially gone after old wreck (5)
23 Tube for old poet with bad cut (7)
24 Legate harried by young bird (6)
25 Behind, going more quickly, but not strong – finishing 3rd (6)

DOWN

1 Might about 500 dust? (6)
2 Anatomical feature of sifaka or tamarin (5)
3 Chuck sibling in frame (7)
5 Tattooed kid playing with needle case (5)
6 Learner dismissed by US college joins university to make acacia extract (7)
7 In north, willow is more curious (6)
8 Broken, torn-hearted figure (11)
14 Silver darling for woman's jewellery (7)
15 Gases produced by teachers taking time (7)
16 Pilots experience this thing, in the end, instead of church (1,5)
17 Bug outside, causing terrible, endless itching (6)
19 Make case for Rankine, seized by fever (5)
21 Accessory for PC's second deployment (5)

Our games are now solvable online
newscientist.com/games

Quick quiz #327
set by Tom Leslie

1 To the nearest 10 years, what is the maximum lifespan of a naked mole rat (as far as we know)?

2 Radar measurements of Mars show a surprising amount of ice at the planet's equator. But how did researchers recently propose it got there?

3 A new type of lithium-ion battery reported in *Nature Energy* last month had what incredible new ability?

4 Researchers in Sweden have designed a special kind of e-paper that can display images at high resolution and in full colour. Which famous painting did they use to demonstrate this?

5 The Orionid meteor shower is caused by debris from which comet?

Answers on page 47

BrainTwister
set by Peter Rowlett

#98 S · P numbers

S · P numbers are multi-digit numbers in which no digit is 0 and the number is equal to the sum of its digits multiplied by their product. For example, the sum of the digits of 135 is 1 + 3 + 5 = 9. The product is 1 × 3 × 5 = 15. Since 9 × 15 = 135, this is an S · P number.

A super-S · P number is a multiple of the sum of its digits multiplied by the product of its digits. What is the smallest super-S · P number?

A sub-S · P number is a divisor of the sum of its digits multiplied by the product of its digits. Can you find a two-digit sub-S · P number whose digits sum to 12?

Find a three-digit super-S · P number (a multiple of the sum of its digits times the product of its digits) whose digits sum to 4.

Answers next week

Crack the case

What is the best way to pack a suitcase to get the most clothes into it? Is it with as few folds as possible? Or is it to roll the clothes up tightly? Is there any mathematical basis behind the answer?

Mike Follows
Sutton Coldfield, West Midlands, UK
Think of packing as a real-life version of *Tetris*. You should roll soft, flexible clothes like T-shirts and pyjamas. Some advise folding formal wear like jackets and shirts, but this can introduce creases. Small items, such as socks, can be stuffed inside shoes.

Use compression cubes or zip-up vacuum bags. Waterproof bags can also be repurposed for this task, as long as the air is expelled from the closed end and the fastening is secured once all the air has been removed, so that pressure isn't exerted on the seams.

Packing solid objects can be a challenge. After a Duke of Edinburgh expedition, I was repacking tents, gas canisters and Trangias (lightweight camping stoves with pots and pans, all nested together) into the same 100-litre holdall they had arrived in. I was struggling to close the zip,

"To fit as many items as possible into a suitcase, you need to exclude as much air as possible from between the layers of clothing"

even though I knew everything should fit. A colleague grabbed the holdall, turned it on its end and gave it a few firm shakes. The contents magically shuffled down and the zip could be closed. I have since discovered that this trick works for holiday packing, too.

Mark Wareing
Seaford, East Sussex, UK
In order to fit as many items of clothing as possible into a suitcase, you need to exclude as much air as possible from between the layers of clothing. It is possible to purchase sealable vacuum-compression bags for clothing, which allow much of the air to be removed with an electric pump and so can increase the amount of clothing in a given volume – although there would still be pockets of air around this sealed inner bag.

Another method is to overfill the suitcase by about 50 per cent, then squash the clothing inside and fasten the case while someone sits on the lid to compress the clothes and force out the air. It would be interesting for an astronaut to pack a suitcase in the vacuum of space, to test this principle.

Matthew Adams
Cambridge, UK
This is a volume problem. Much of the space taken up by clothes is in the gaps of air between them. This is why vacuum-packing clothes in plastic is the most efficient solution (and commercial products are available that can do this). Folding is then better than rolling, as cuboid blocks pack together more closely than cylinders. The fewer, sharper folds, the better.

BOTANY VISION/ALAMY

This week's new questions

Hard graft **Can any two plant types be grafted together, or is "rejection" an issue?** ***Robert Watson****, Jesmond, New South Wales, Australia*

Wake-up call **My partner says he wakes up in the night as he needs to urinate. But could it be he needs to urinate because he has woken up? Jenny Ozanne***, Guernsey, Channel Islands*

Over the edge

If two particles were entangled and one fell into a black hole, what happens to the other? What might we learn from this?

Vlatko Vedral
University of Oxford, UK
The answer depends on how you think about quantum gravity. If you think that the black hole destroys information irreversibly (i.e. that classical gravity "wins" over quantum mechanics), then the entanglement between the particles is gone. If, on the other hand, you think that black holes obey quantum mechanics, then entanglement persists, though how exactly would depend on the dynamics of the particle inside the black hole and during the eventual evaporation of the black hole. At present, we don't have a definitive answer because we lack a quantum theory of gravity.

Martin Bastone
East Grinstead, West Sussex, UK
One particle would think it had been ghosted and the one that fell into the black hole would form a new entanglement with Schrödinger's cat!

Cloud colour

Why do rainbows refract light into several different colours, but we don't see the same effect with cloud inversions? (continued)

Natalie Roberts
Watford, Hertfordshire, UK
There are two different ways you can observe water droplets' optical effects when facing away from the sun into the low clouds (fog and mist) caused by an inversion (when cool air becomes trapped under warm air). However, one involves an uncommon perspective on the cloud and the other is fairly unremarkable, so neither is common knowledge.

The Brocken spectre effect typically involves standing by the cloud edge, usually from just above it, so it is most commonly observed by climbers – although standing on a hill above valley fog would do it. Here, the tiny, uniform water droplets – typically less than 0.05 millimetres across – refract the light from behind you and cause a ring of repeating rainbow light to form around

Is it possible to graft any plant type to any other, or will they be "rejected"?

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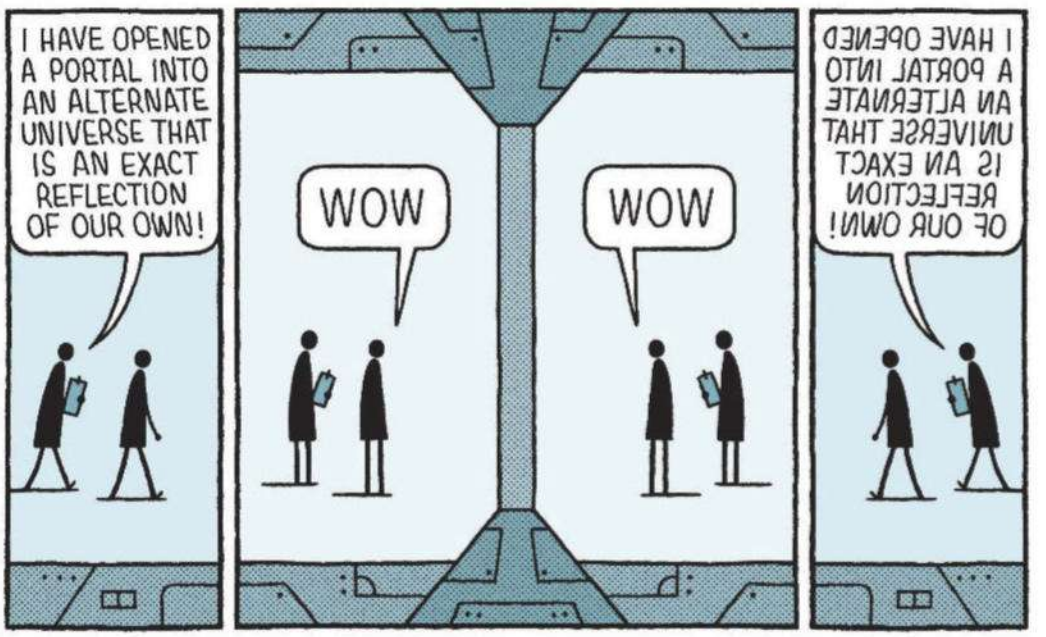
Tom Gauld
for New Scientist



your shadow: a glory. This will always appear around your own shadow, no matter how many people are with you.

The other phenomenon is the fog bow, or white rainbow. This can be seen from within fog, so long as there is strong sunlight or moonlight behind you, and is for all intents and purposes a normal rainbow. However, here light diffracts through the small water droplets to blur out all the classical rainbow colours, leaving a mostly white bow with perhaps a faint red outer edge and blue inner edge. Because of this, the fog bow typically goes unnoticed. But, of course, that isn't the same as not existing.

Sight unseen

Is short-sightedness found in other animals? Did it also affect ancient humans? (continued)

Helen Blyth
Liverpool, UK
In his answer to this question, Peter Bursztyn writes that he isn't sure "how one could determine whether a wolf, an eland or a cheetah were short-sighted". He says: "I can't imagine devising something like an optometrist's eye chart for animals."

"A letter chart is only used to find the size of target that the eye can discern. We could easily check if a cheetah were short-sighted"

As an optometrist, I can tell him we use retinoscopy to determine whether an eye is short-sighted, long-sighted or astigmatic. This technique doesn't require any input from the subject and would therefore work on a wolf just as well as on a human.

A letter chart is only used to establish the size of target that the eye can discern. This depends on how healthy the eye is, as well as whether it is in focus. So we could easily check if a cheetah were short-sighted, but it would be harder to learn what they can distinguish.

Michael Burrows
Harwell, Oxfordshire, UK
Our flat-coated retriever revealed his short-sightedness on many occasions. The most convincing example was the time he tensed up as a man with a wheeled suitcase approached in the distance. As we got closer, he finally recognised it wasn't another dog and instantly relaxed.

Alex Harrison
Plettenberg Bay, South Africa
We identified my Australian shepherd dog's short-sightedness quite early on. Unlike our other dogs, if he detected a family member on the other side of the garden, he would bark angrily as if discovering an intruder. If said family member then called out to calm him, he would immediately recognise them and rush over to greet them. It quickly became very clear that he can't identify anyone standing about 5 metres or more away by sight, so he therefore has to rely on other senses. He still manages to get by perfectly well, though!

Answers

Quick quiz #327 *Answer*

1 40 years
2 It was blasted there by volcanic eruptions
3 It could be pierced with a nail without catching fire
4 *The Kiss* by Gustav Klimt
5 Halley's comet

Quick crossword #195 *Answers*

ACROSS 1 OpenXR, **4** Coccus, **9** Koch, **10** Roundabout, **11** Matrix, **12** Numeracy, **13** Palladium, **15** Suns, **16** Sump, **17** Struck off, **21** Airspace, **22** Deform, **24** Human error, **25** Lead, **26** Eleven, **27** Dot com

DOWN 1 Odonata, **2** Ether, **3** Xeroxed, **5** Oedema, **6** Cyberpunk, **7** Sources, **8** Quantum theory, **14** Limescale, **16** Seizure, **18** Undergo, **19** Forearm, **20** Gamete, **23** Folic

#97 Picking and choosing *Solution*

For a set with no consecutive pairs, you can choose only even numbers for a set of 50. For a set with no three consecutive numbers, take pairs with a gap of 1 between for a set of 66 numbers. For a set where no numbers differ by 2, take a pair of consecutive numbers, then skip the next two, then repeat. This means you can have 50 numbers. For a set that contains no sequence of three numbers that increment by 2, you can take a run of four numbers, then skip the next two, and repeat – using only numbers with a remainder of 1, 2, 3 or 4 when divided by six. This means you can have 68 numbers.

Mechanical turk

Feedback is a grumpy sort, so we run a mile when faced with any kind of enforced fun. It is possible, therefore, that we would struggle to buy an ice cream in Turkey, because doing so requires enjoying, or at least tolerating, an extended prank.

Turkish ice cream vendors are prone to playing tricks on their customers, like handing them a cone full of ice cream only to whisk it out of their grasp using sleight of hand. The routines are genuinely impressive and take years to master. It's just that, if Feedback wants an ice cream, we want an ice cream, not a close-up magic show.

So we groaned inwardly when reporter Matthew Sparkes alerted us to a new early-stage paper uploaded to the website arXiv, in which engineers describe building a robot that can mimic the Turkish ice cream vendor routine. They did this, Matt suggests, "because all the important research has been finished".

The result is one of those robot arms that can twist and rotate and generally swing all over the place. The researchers programmed it with five Turkish ice cream vendor tricks.

In one, the robot "bounces" the cone from side to side, "creating the illusion that the cone is 'hopping' away from the user". In another, the robot "dodges the [user's] hand by drawing a large, arcing path when the hand reaches the cone". And then there's "dancing", which is "a non-interactive policy that is intended to tease/taunt users by circularly waving the cone upright out of the reachable range of the users."

The robot was then tested on actual people. Compared with a control condition where the robot just handed over an ice cream without any mucking around, the tricks caused people to rate it as "more deceptive". Apparently the tricks also "increased enjoyment-related outcomes (pleasure, engagement, challenge) and perceived robot competence, but decreased performance trust... perceived safety, and self-competence".

Twisteddoodles *for New Scientist*

I'M A LITTLE BEAKER, SHORT AND STOUT, HERE'S MY MEASUREMENTS, HERE'S MY SPOUT
IF YOU WANT AN INCIDENT REPORT TO FILL OUT
KNOCK ME OVER AND SPILL ME OUT!!
@twisteddoodles

Got a story for Feedback?

Send it to feedback@newscientist.com
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Consideration of items sent in the post will be delayed

In other words: "Playful deception produces a structured tradeoff: it can delight and sustain attention but at the cost of predictability and trust." The authors recommend that "in safety-critical applications... the associated declines in trust and safety would likely be unacceptable". Really? You think?

Apposite acronyms

When Feedback first asked for your suggestions for the best and worst scientific acronyms, we had no idea of the torrent that was coming our way. Our inbox groans under the weight of tangled word combinations abbreviated into sequences of capitalised letters.

For instance, Stuart McGlashan notifies us about a conservation project that aims "to rejuvenate the marine and coastal environment of the Solway": an inlet on the west coast of Great Britain, on the border between England and Scotland. It is called the "Solway Coast And Marine Project", or SCAMP.

Stuart feels that the creators of the project have been unduly restrained. Given the emphasis on "restoration of sea life", he says, might they not have appended one more word to achieve an even more apposite acronym? Feedback agrees: it should definitely have been the Solway Coast And Marine Preservation Initiative.

On the other side of the world, Jamie Pittock and Jennie Mallela at the Australian National University recently got funding for a project to study how the rivers flowing into the Indian Ocean are managed. Niftily, they called it "Management Of Rivers Discharging into Ocean Realms (MORDOR)".

However, this one is actually a cautionary tale. Jamie writes: "When we advertised for a research officer, a Mr Bilbo Baggins from the Shire applied. Fortunately a vastly more qualified candidate was available and has been appointed."

Shakespeare shake-up

Recently, Feedback explained that we need to rewrite two of William Shakespeare's sonnets to remove erroneous references to roses having thorns; those sharp things are actually called prickles. Reader James Fradgley has now written in to say that Shakespeare's scientific illiteracy extends way beyond botany, into astronomy.

In *Julius Caesar*, act 3, scene 1, the eponymous dictator boasts: "I am constant as the northern star / Of whose true-fix'd and resting quality / There is no fellow in the firmament." Caesar is referring to Polaris, which is so close to the celestial north pole that it barely moves at all in the sky, while over the course of the year the other stars rotate around it.

Except that, as James says, at the time of Caesar's assassination in 44 BC, "Polaris was not the northern star". Instead, a star called Kochab or Beta Ursae Minoris was the closest to the northern celestial pole – but it was never quite close enough to really be fixed, so it wasn't that useful for navigation.

"Worse, Polaris is a Cepheid variable," says James. This means its brightness varies on a regular basis, so it doesn't even shine with a constant intensity. "All in all," says James, "I really don't know why we bother with Shakespeare."

Feedback is inclined to be more forgiving. Our astronomical history knowledge isn't good enough to tell us reliably whether the shifting pole stars were known in Europe in Shakespeare's time, but we feel he was busy enough to have justifiably missed out on it. Meanwhile, Cepheid variables weren't spotted until 168 years after his death, which seems to us to be a cast-iron excuse.

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